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Spokane Wastewater Study

Esvelt & Saxon

Bovay Engineers, inc.

SPOKANE

THE CITY —— THE RIVER

ACTION PLAN

FOR

- BETTER WASTEWATER CONTROL ·
- ADVANCED WASTE TREATMENT ·
- HIGH RIVER WATER QUALITY ·
- BETTER ENVIRONMENT ·

ESVELT & SAXTON--BOVAY ENGINEERS, INC.

SPOKANE WASTEWATER STUDY

TEXT

JULY 1972

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
A JOINT VENTURE

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I. SUMMARY

A. BACKGROUND

The City of Spokane sewer system contains combined sewers that overflow during periods of storm runoff. Dry weather sanitary sewage flows are treated in the City's primary sewage treatment plant. Out of concern for the quality of the Spokane River and in response to directives from the Washington Department of of Ecology, the City has commissioned this study and report, which outlines a program for mitigating overflows and upgrading the sanitary sewage treatment plant.

B. POLLUTION CONTROL NEEDS

Periodic bypassing of sewage and wet weather combined sewage overflows lowers the river bacteriological quality below State and Federal water quality standards. The elimination of combined sewage bypassing accompanied by control and disinfection of overflows will alleviate this problem.

Dissolved oxygen depression has been observed in the Spokane River, in the Long Lake Dam Reservoir, and downstream from the Dam. The installation of secondary treatment facilities for Spokane's sanitary sewage flows will improve the dissolved oxygen resources of the river. State and Federal regulations require secondary treatment for sanitary sewage discharges to fresh waters. Presently available information indicates that advanced waste treatment for nutrient removal is not warranted at this time, although provision for its future addition should be incorporated in the design of secondary treatment facilities.

C. OVERFLOW MITIGATION

Five overflow treatment facilities can accept the majority of overflows from the city. Overflows from several locations would be transported to each facility for equivalent primary treatment consisting of fine screening and disinfection. Each of the facilities would have a design flow greater than 100 mgd and would be designed to accommodate runoff from a five year storm. The facilities by location are as follows:

1. The Erie Street Complex. An overflow treatment facility, to be located in the vicinity of Front and Erie will accept overflows from ten locations in that area.

   Immediate priority is given to construction of facilities to eliminate bypassing sewage during periods of high river water levels.

2. The Central Business District - Latah Creek area. An overflow treatment facility would be located in the vicinity of the confluence of Latah Creek and the Spokane River and would accept stormwater overflows from all sewers presently going through the downtown area and from those in the Latah Creek area. Proposed overflow interceptors on the south riverfront and along the freeway route would transport flows to this location.

3. The North Bowl area. An overflow treatment facility would be located at Cedar and Ide to receive flows from an overflow interceptor serving the North Bowl area and the north riverfront from Division Street downstream to Cedar Street.

4. T. J. Meenach Drive. An overflow treatment facility would be located along T. J. Meenach Drive near the Fort Wright Bridge to treat combined sewage from existing overflows occurring in that area.

5. Hollywood Interceptor Complex. An overflow treatment facility would be located on the main sewage treatment plant site. This facility would treat overflows from the northwest area and could accept overflows from the main wastewater interceptor in excess of the sewage treatment plant capacity.

The construction of separate storm sewer systems is the recommended alternative for elimination of combined sewage overflows in selected areas.

D. SANITARY SEWAGE TREATMENT

The construction of a single biological sewage treatment facility adjacent to the present wastewater treatment plant site appears to be the most feasible method for complying with requirements for secondary treatment of dry weather flows. This construction has been given immediate priority for completion.

E. ESTIMATED COSTS

Cost of the recommended facilities to provide secondary treatment for sanitary sewage flows and mitigation of overflows is estimated at $36,250,000 based on 1972 costs. Grants of about 80 percent must be obtained to accomplish the recommended entire construction in a ten year period. After installation of recommended facilities, annual O & M costs are estimated to increase nearly $800,000 above present levels. The two immediate priority items, secondary treatment plant and bypass elimination at Erie Street, could be financed under existing programs.

II. INTRODUCTION

A. BACKGROUND

The City of Spokane owns and operates a sewage collection system including trunks, interceptors, pumping stations, and treatment works located within the City of Spokane. The study area and major facilities are shown on Exhibit II-1. The main combined sewer system mains carry both sanitary and storm drainage flows. During dry weather periods, the sanitary wastes are treated by the primary treatment plant prior to discharge to the river. During periods of storm runoff, the sewer system capacity may be exceeded resulting in discharges directly to the river at 45 overflow locations. These overflow locations are shown on Exhibit II-2. Unsewered regions are shown on Exhibit II-3. During the average year, about 1 percent of the city's total volume of sanitary waste is discharged untreated to the river.

The Spokane River is designated by the State of Washington as a Class A river. The waters should be suitable for water supply, wildlife habitat, general recreation, aesthetic enjoyment, picnicking, hiking, fishing, swimming, and other beneficial uses. The present sewer system allows discharge of the untreated wastes to the river, resulting in violation of some of the criteria for Class A waters.

The Washington State Water Pollution Control Commission, presently the Department of Ecology, initiated action in March, 1968, requiring the City of Spokane to:

1. Upgrade existing treatment facilities to secondary treatment and provide improved disinfection.
2. Conduct a study to assess the nature and magnitude of excessive flow problems.
3. Determine the most feasible methods of effectively controlling or eliminating overflows.
4. Develop a staged construction program to achieve orderly completion of the total project.
5. Prepare cost estimates for project construction to develop a financial program to achieve project completion.

B. PURPOSE AND SCOPE OF THE STUDY

1. Purpose

In order to comply with the above directives, the City of Spokane must improve the City's sewage collection and waste treatment system. The directives generally called for improved treatment of the waste now being discharged to the Spokane River from the Spokane treatment plant and for elimination, reduction, or treatment, of the storm sewer overflows which are a product of the City's combined sewer system.

On August 7, 1970, the City executed a contract with Esvelt and Saxton / Bovay Engineers, Inc., a joint venture, to conduct a study and prepare a report outlining methods for compliance with these requirements. This report presents the study results.

2. Scope

The major study phases were:

a. Inventory and evaluate present facilities.

b. Compile hydrologic data, growth patterns, and trends.

c. Evaluate traditional and advanced waste treatment methods.

d. Evaluate methods for controlling the wastewater overflows.

e. Develop a phased construction and financial program.

C. ORGANIZATION OF THE REPORT

Small graphs, tables, etc., appear within the text. Most maps and graphs are on exhibits bound on the right-hand side of this report. The report pages are numbered consecutively. Exhibit numbers are assigned on the basis of the chapter number in which they are first referenced.

Chapters II through VI describe the existing system, its background, and other characteristics of the study area. Chapters VII through X define and discuss the problem areas. Chapters XI through XIII discuss proposed improvements and present a candidate program for alleviation of the defined problems.

III. CONDUCT OF THE STUDY

A. CHARACTERISTICS OF SPOKANE

Background data for the characteristics of Spokane was compiled from existing maps and reports and condensed for inclusion in this report. The population contribution for each trunk system was based on the 1970 total population for the City of Spokane, as officially published by the U. S. Bureau of the Census, and was distributed on an acreage basis by Census tracts.

B. SEWERAGE SYSTEM

1. Service Areas

A sewer system map was compiled from City drawings and other data, showing all sub-trunk, collector and interceptor lines currently in use. Points of overflow and outfall to the Spokane River were located from City drawings and from field inspection.

The collection system was divided into ten zones with these in turn being subdivided into 63 sub-trunk or sanitary service areas for system analysis and evaluation.

2. Drainage Basins

Surface drainage basins were delineated from city data. Their boundaries do not coincide in all cases with those of the sanitary service areas. They were determined separately in order to calculate the storm runoff contribution to the sewer system.

3. Television Inspection of Central Business District Sewers

A television inspection of the central business district sewers was conducted from June 1, 1971, through June 11, 1971. The inspection was conducted by personnel from the City Sewer Maintenance Division and was observed by project personnel.

C. WASTEWATER FLOWS

1. Data

The City of Spokane furnished water use records and sewage treatment plant operating reports. Per capita water use and sewage flow figures were obtained using the operating records and Census data. Measurements of sewage flows by project personnel and rainfall data obtained from the U. S. Weather Bureau were used to affirm runoff calculations.

2. Storm Flows

The runoff from individual drainage basins was calculated by means of the rational formula and then accumulated to determine maximum flows at junctions of the trunk sewers. The five-year storm frequency curve of the rainfall intensity-duration curves for Spokane, as published by the Washington State Highway Department, were used in all calculations. Runoff coefficients were assigned to areas based on published data and correlations determined from sewer flow studies conducted during this project.

3. Flow Measurement at Selected Points in System

Flow was measured at selected points within the system to establish runoff characteristics. These measurements were continued for a sufficiently long period to reasonably establish the average sanitary or dry weather flow in addition to flow under storm conditions.

4. Flow at Treatment Plant

Recorded treatment plant flows were available, but a record of the quantities bypassed was not, except for a short period during this study when interceptor flows entering the plant were measured.

5. Field Flow Measurements

a. Instruments

Total flow and overflow quantities were measured at selected points within the system. Instruments used were the Stevens Type F Liquid Level Recorder, Bristol Constant Purge Bubble Tube Level Recorder, and battery-operated clocks.

b. Overflow Recording Procedure

A level recorder was installed at the first point of access upstream from the point of overflow to record total flow. A battery-operated electric clock, equipped with a float-operated switch or electronic liquid sensor to stop the clock when overflow began was installed in the overflow line. The recorder chart, at the time shown by the clock, indicated the magnitude of flow required to create an overflow. All flow recorded in excess of this amount was considered as overflow.

Overflows from some smaller lines (8 inch to 15 inch diameter, etc.) were estimated by taking several recordings, both upstream and downstream of the overflow weirs.

All overflow weirs and dams were physically measured and their existing and maximum capacities calculated. Capacities of the connecting lines to the interceptor and the incoming trunk lines were also calculated for comparison with weir capacities.

D. WATER QUALITY

The normal program of sampling and testing conducted by personnel of the sewage treatment plant was expanded to include more frequent sampling and testing for nitrogen and phosphorus. Major overflows and separate storm sewers were sampled during wet weather to determine the runoff and combined sewage strengths. Grab samples were collected from selected points within the sewer system to determine whether any areas were contributing wastes of unusual quality. Samples were delivered to the sewage treatment plant for analysis and tabulation. Analyses for nitrogen and phosphorus were performed by a commercial laboratory.

IV. CHARACTERISTICS OF THE CITY

A. PHYSICAL CHARACTERISTICS

The City of Spokane, located in Spokane County, Eastern Washington, is the hub of a region extending from Missoula, Montana, on the east to Wenatchee, Washington, on the west; from the Canadian border to the Oregon border. The city is located near the center of Spokane County and contains 51.32 square miles within the corporate boundary. The commercial and business center is concentrated around the Spokane River near Spokane Falls. Residential areas are located north, east and south of the city center. There is limited urban growth to the west. The Spokane River enters the city from the east, passes over Spokane Falls in the downtown area and exits to the northwest.

The study included the area within the corporate limits of Spokane, shown on Exhibit II-1, and contiguous areas which drain to the city. The central business district has been defined as the area between Maple and Division Streets, bounded on the north by the Spokane River and on the south by Interstate 90 freeway.

Mountainous areas are north and east of Spokane. The Spokane Valley is adjacent to and east of the city. Plateaus lie west and southwest of the city. Spokane International Airport and Fairchild Air Force Base are located on the westerly plateau.

Spokane lies near the interface of the Columbia lava plains and areas carved by the great continental ice sheets. To the west and south lie basaltic formations characteristic of the Columbia Basin. Valleys within the mountainous areas to the north and east contain glacial outwash.

Spokane is underlain with a granitic foundation to a level of approximately 900 feet above sea level. This foundation is covered with a 700 foot thick clay and shale formation of fresh water origins known as the Latah Formation. The Latah Formation in turn is covered by 4 feet to 600 feet of incoherent or loosely coherent gravel and sand. The gravel and sand are the result of deposits left by great outpourings of water emanating from the retreating glaciers of the ice age.

There are two types of basaltic formations evident in the city. Rimrock basalt is found at higher elevations and is characterized by its columnar formations. Valley basalt is found at lower elevations and is characterized by its massive formations with irregular jointing. Basalt flows are found in the southern and western parts of the city and in the Five Mile Prairie area to the north.

Exhibit IV-1 shows the distribution of various soil types within the study area. Contours within the area are shown on the zone maps referred to in Chapter VI.

B. POPULATION

The historic population growth of the City of Spokane is shown on Exhibit IV-2. The data presented is for the Census years between 1910 and 1970. Exhibit IV-3 shows the 1970 population for each Census tract in the study area. The total population of Spokane was 170,516 in 1970, a drop of 9,000 from 1960.

The metropolitan area did not experience a loss of population, indicating there was a population shift to the suburbs. Historically the population growth of Spokane has been relatively stable with major increases occurring only between 1940 to 1960. The decline of the 1960's is not expected to continue and future growth will occur at a more moderate rate.

Population density was calculated from Census data shown on Exhibit IV-3. Exhibit IV-2 shows population projections for the various sewer zones.

C. LAND USE

1. Present Land Use

Table IV-A is a tabulation of land uses in 1967. Exhibit IV-4 is a generalized zoning map of the city.

Residential areas are quite uniformly distributed over the entire city, with the exception of the south side of the immediate upriver area and the city center proper. Business and commercial usage is primarily located in the central business district and along the major arterial streets. Industrial zoning is generally located along the upper Spokane River, extending eastward from the city center and on the northeast edge of the city. Spokane possesses many well maintained public parks and playgrounds quite evenly distributed throughout the area.

TABLE IV-A

EXISTING LAND USE - 1967
City of Spokane (in acres)

RESIDENTIAL		8,713.65 Acres
1 Family	8,202.73 Acres	
2 Family	233.93	
3 Family	115.17	
Multiple	161.82	
BUSINESS & COMMERCIAL		991.79
Local Business	159.70	
General Business	588.79	
Wholesale & warehouse	203.86	
Tourist	39.44	
INDUSTRY		1,437.05
Light	547.80	
Heavy	573.71	
Railroad	315.54	
PUBLIC & SEMI-PUBLIC		3,818.91
Parks & park lands	1,778.38	
Public bldgs. & schools	1,004.51	
Semi-public bldgs. & lands	862.27	
Public utilities	173.75	
AGRICULTURE		307.49
Nurseries & farm lands	307.49	
VACANT		9,937.27
Undeveloped	9,937.27	
Subtotal		25,206.16
Streets and alleys		7,098.63
TOTAL LAND AREA		32,304.79
Water		543.00
GROSS AREA		32,847.79 Acres
		(51.32 sq. miles)

Source: Land Use Inventory. City Plan Commission. January 1, 1967 plus land annexed north of Francis between Division and Nevada Streets on September 13, 1967.

2. Future Land Use

Residential areas are anticipated to remain in that category. Some reclassification will be experienced; i. e., single family to two family, two family to multi-family, etc. Most new areas of annexation will probably be in the residential categories.

Business and commercial land usages will increase to accommodate residential development. These increases are expected to occur adjacent to existing and future arterial streets.

Only minor expansion of industrial land use within the present city limits is anticipated. Extension of the city limits could annex new industrial areas east and northeast of the city.

D. ECONOMIC INFLUENCES

This section deals with the present economic factors that will influence the city's ability to undertake major capital improvement programs. All figures are based on records as of March 2, 1972, unless noted.

1. Assessed Valuation and Property Taxes

The non-exempt assessed valuation of the city is $511,620,930. Property is assessed at 50 percent of the par, or normal market value. Assessed valuation of property exempt from taxation was estimated to be $98,964,000. The County Assessor is not required to keep accurate records of this classification and they may therefore be incomplete. This figure represents approximately 18 percent of the total valuation.

The city tax levy in Spokane is based on 7 mils for the general fund and 1 mil for the fireman's pension for a total city tax rate of 8 mils. In 1971 a business and occupation tax amounting to 1/4 of 1 percent of gross revenues was levied on businesses operating in Spokane. A nominal tax to support public transportation is levied on each household within the city.

2. Indebtedness

The City of Spokane had $7,138,000 outstanding in general obligation bonds. At the beginning of 1972 the City of Spokane had $676,000 outstanding in revenue bonds. Of this total, $100,000 was for golf courses, and $576,000 was water and sewer bonds.

At the beginning of 1972 there was an outstanding balance of $3,135,000 in councilmanic bonds, which are classed as general obligation bonds, and some of which are included in the general obligation bond total above. This figure does not include authorized riverfront development bonds.

3. Bonding Capacity

The bonding capacity or limit on bonds which a city may issue is based on the assessed valuation of the community. A Washington community is authorized to issue general obligation bonds up to 2 1/2 percent of assessed valuation. Councilmanic bonds are limited to 0.75 percent of assessed valuation. Revenue bonds have no ceiling, and may be issued up to the capacity of the facility to repay through earned revenue.

4. Water and Sewer Service

Water service in Spokane is metered and charges are based on an initial fee plus a consumption charge per unit of water used. A rate schedule is available from the city. In 1970, the operating revenue for the water system was $3,377,945. Operating and maintenance costs were $1,922,624. Total expense, including taxes, was $3,110,783, leaving a net income of $267,162.

Spokane charges a flat rate for sewer service to single dwelling units, with a graduated rate based on water consumption applying to other connections. Provision is made for surcharges based on strength of waste received from industrial and commercial establishments. A rate schedule is available from the city. In 1970, the operating revenue for the sewer system was $1,262,523. Operating and maintenance costs were $608,625. Total expense, including taxes, was $1,035,713, leaving a net income of $226,809.

A 1971 sewer rate increase to $3.50 per single dwelling unit from $1.50 and commensurate increases for other services has raised income figures. The additional revenue has been designated for construction and operation of improved sewage facilities.

Special water and sewer rates are granted to churches and certain public or charitable institutions.

V. THE SPOKANE RIVER

A. PHYSICAL DESCRIPTION

The Spokane River originates in Idaho's Lake Coeur d'Alene and flows westerly to its confluence with the Columbia River, a distance of over 100 miles. The City of Spokane is located on the river about 70 miles from the river mouth and about 20 miles from the Washington-Idaho boundary. Exhibit V-1 shows the location of the river and major communities.

Seven power generating dams are located on the river [5-1]. All but one of the dams are owned and operated by the Washington Water Power Company, and the six dams have a combined rating of about 140,000 kilowatts. The remaining dam, Spokane Dam at Millwood, is owned by the City of Spokane and is rated at 3,900 kilowatts. Of the approximately 840 feet of drop from Lake Coeur d'Alene to Lake Roosevelt, about 530 feet is utilized for power generation through the seven dams.

The dams are predominately run-of-the-river dams; but Long Lake Dam, a little over 30 miles from the confluence with the Columbia River, creates an impoundment in the Spokane River with about 5,000 acres of surface area, a length of about 22 miles and a maximum depth of 180 feet. The volume is roughly 250,000 acre feet, with about 100,000 acre feet as active storage.

An alluvium filled glacial trough underlays the route of the Spokane River, east of Spokane to Lake Coeur d'Alene. This geological formation which contains an aquifer which extends northeastward from Post Falls as far as Lake Pend Oreille and conveys flow from the vicinity of Lake Pend Oreille, Spirit Lake and Hayden Lake, as well as Lake Coeur d'Alene. Springs along the Spokane River, in and upstream of Spokane and along the Little Spokane River north of Spokane, are apparently the main discharge points for this aquifer. The total aquifer flow, westerly from the Idaho-Washington boundary, has been estimated at 1,200 cfs [5-2]. The City of Spokane and communities in the Spokane Valley obtain their water supplies from this aquifer.

B. FLOW

As the river drains a relatively large and mountainous area of Eastern Washington and Northern Idaho, a large proportion of its annual flow originates from snowmelt runoff. Flows are considerably greater during late winter, spring and early summer than during the rest of the year. The annual flow fluctuation for the Spokane River at points above and below Spokane is shown on Exhibit V-2. The curves represent average values for the period September, 1966, to July, 1971. The difference between the two curves represents local runoff plus inflow from Latah Creek and the aquifer underlying the river.

Exhibit V-2 indicates that minimum river flows occur during late July, August, and September. The four year average flow for August, 1967-1970, at a gage located downstream of the Maple Street Bridge in Spokane was 1,000 cfs. This represents approximately the minimum dilution flow for wastewater emanating from Spokane.

C. QUALITY

The Spokane River, at the Idaho-Washington boundary, has an annual average dissolved solids content of about 40 mg/l. The alkalinity and hardness at this point each average about 20 mg/l as $CaCO_3$.

Below Spokane at the Seven Mile Bridge, the dissolved solids have increased to an annual average of about 80 mg/l and alkalinity and hardness to over 40 mg/l as $CaCO_3$ each. The river contains about 0.04 mg/l of zinc. This amount of zinc is nearly 50 percent of reported 96 hr TL_{50} values for rainbow trout at this water hardness [5-3].

1. Bacteriological Quality

The bacteriological quality of the river is influenced by the human activities within the watershed. Coliform levels in the river, as determined by various individuals and agencies, are shown on Exhibit V-2. The coliform concentration at the Idaho-Washington boundary met Interstate Waters Class A Standards, increased by a small amount by the time it reached Spokane, where a sharp increase occurred. This sharp increase, consistently noted during all surveys, indicates raw sewage entered the river upstream of the Fort Wright Bridge.

This consistent increase in coliforms may have been attributable to the bypass overflow situation in the Erie Street area (see Chapter VIII), other malfunctioning overflows, or discharges from the Post Office Annex area. The Post Office Annex area has recently been connected to the interceptor since these studies were conducted. A decrease in coliform level occurred downstream of the Fort Wright Bridge. No perceptable increase in coliform levels were noted in the vicinity of the sewage treatment plant.

Grab samples obtained during this study from the river at the Bowl and Pitcher, about 1 mile below the sewage treatment plant discharge, showed coliforms to be at 70/100 ml on July 31, 1971, when no overflows were occurring, but to be 46,000/100 ml on December 17, 1971, when overflows were contributing to the river. Treatment plant effluent from 1967 through 1971 had a median coliform level of about 2,900/100 ml.

It appears that the elimination of sources of bacterial contamination from Spokane's overflows and direct discharges would result in a marked improvement in the bacteriological quality of the Spokane River. Lesser improvements would result from elimination of upstream sources and from improving the degree of disinfection of Spokane's treated sewage effluent.

2. Oxygen Resources

The oxygen resources of the Spokane River are influenced by the river flow, temperature and the wastewater entering the river. A figure on Exhibit V-3 shows the dissolved oxygen (D.O.) levels presented by the Washington Department of Ecology, two curves representing seasonal averages and two representing levels during short term surveys. The winter-spring season curve reflects the effect of lower water temperatures and higher flows than were present during the summer season or the short term surveys. Lower water temperatures have a higher oxygen saturation concentration and additionally retard the rates of oxygen removal reactions, thus resulting in higher D.O. concentrations. Higher river flows provide greater dilution for oxygen demanding substances.

In September, 1966, a study by the Washington Water Pollution Control Commission [5-4] reported by Cunningham and Pine showed a marked D.O. decrease downstream from the Argonne Road vicinity, probably reflecting the impact of the pulp mill discharge at that location. The later data did not show this dip, and the mill had, in the interim, altered its manufacturing process and improved its waste handling practices. The reaeration resulting from turbulence through Spokane was reflected in higher D.O. readings at the Fort Wright Bridge. Lower D.O. readings were found in the river at the discharge from Long Lake Dam. A similar pattern except for the lack of pulp mill influence was obtained on August 15, 1971. D.O. levels in the Long Lake Dam discharge were well below those recommended for fish survival, 5 mg/l, as well as being below the Class A Water Quality Standard, 8 mg/l. Samples from below Long Lake Dam showed D.O. concentrations to be below Class A standards from mid-July through mid-October, 1970, and mid-August through September, 1971 [5-5].

The Washington Water Pollution Control Commission report covering the 1966 survey [5-4] showed anaerobic conditions occurred in the hypolimnion of the Long Lake Dam reservoir and concluded that the oxygen deficit resulted almost exclusively from decay of algae and planktonic forms. They also indicated the algal growth in the reservoir was stimulated by the nutrients, nitrogen and phosphorus, present in the Spokane sewage discharges. This report used as evidence a mass balance showing 37,000 lb./day of D.O. to be entering the reservoir and only 20,000 lb./day of 5-day BOD. However, the report also showed nearly 180,000 lb./day of volatile suspended solids entering the reservoir. Most of the volatile suspended solids were added in the vicinity of the sewage treatment plant as shown on Exhibit V-3. They probably resulted from sewage suspended solids and biological growth utilizing the sewage constituents, BOD, as substrate. These solids settle out in the impoundment and exert an oxygen demand in the hypolimnion along with the dead algae.

Studies by the Washington Department of Ecology in 1971 [5-5] showed low D.O. conditions to exist in deeper waters of Long Lake Dam Reservoir just upstream of the dam from July 10 through September 21. The D.O. was depleted below 20 feet depth on September 1 and below 50 feet on September 15. D.O. levels less than 5 mg/l occurred further upstream in the reservoir at depths below 20 feet during a portion of the summer. Anaerobic conditions were not observed at these upstream sampling stations as they were in 1966. An apparent improvement occurred in the interim.

The improvement could be attributed to the reduction in BOD discharged by the pulp mill above Spokane. D.O. resources in the river below Spokane and in the Long Lake Dam Reservoir would be improved by the installation of secondary treatment for Spokane's sewage. The degree of improvement cannot be accurately predicted.

3. Nutrients and Algal Growth

Cunningham and Pine [5-4] attributed oxygen problems below Long Lake Dam to the decay of algal populations stimulated in the reservoir by the nutrient, nitrogen and phosphorus, input. Bishop and Lee [5-5] apparently concurred with this conclusion, although they did not so strongly imply that nutrients from the City of Spokane were the primary contributor to excessive algal production. There appears to be questionable justification to attribute the entire oxygen problem to algae, as significant oxygen demand is introduced from other sources as discussed above. However, excessive algal growth may contribute significantly to oxygen depression. The cause and means for control of excessive algal growth are not resolved.

Condit [5-6] in 1971 in collaboration with the study reported by Bishop and Lee [5-5] quantitated the algal population in river samples taken June 15 and August 17. Total cell counts reported by Condit are shown in Table V-A. Algal growth was considerably greater in June than in August. The June 15 samples showed a significant increase in algal population in Long Lake Dam Reservoir over that in the river above Spokane. On August 17 this increase was not observed. The greatest algal problems apparently occur during high river flows when Spokane's sewage should have minimum influence.

TABLE V-A

SPOKANE RIVER ALGAE LEVELS [5-6]

Location	Total Algal Cell Count/ml June 15, 1971	August 17, 1971
Sullivan Road	1904	342
Green Street Bridge	1588	288
Fort Wright Bridge	1576	354
Bowl and Pitcher	1492	402
Long Lake Dam Reservoir (just upstream from dam)	3564	300

Organic nitrogen is usually the result of biological growth and may be correlated to the quantity of biomass, primarily bacteria or algae, in water. The result of analyses of Spokane River water for organic nitrogen are shown on Exhibit V-4.

Data on the reservoir presented by Cunningham & Pine [5-4] showed the organic nitrogen content in surface waters to exceed that at greater depths. This indicates it was included in a living biomass capable of selecting its depth of habitation, algae. The pH was greater in surface waters, indicating algal activity was present, as algae utilize CO_2 for synthesis, thus increasing the pH. The epilimnion average organic nitrogen in Long Lake Dam Reservoir exceeded that in the river above Spokane by 25 percent, indicating a modest increase in algae content. The hypolimnion average organic nitrogen concentration was only about half of that in the river above Spokane.
There is not conclusive evidence available to indicate algal blooms occur in Long Lake Dam Reservoir as a result of Spokane's nutrient input.

Figures on Exhibits V-4 and V-5 show phosphorus, nitrate nitrogen and ammonia nitrogen levels reported in the Spokane River. Spokane contributes a major amount of the phosphorus contained in the river during the low-flow months. However, during June, 1971, when the highest level of algal population was recorded, Table V-A, the phosphorus increase due to Spokane's sewage treatment plant effluent was negligible.

The nutrients nitrogen and phosphorus are essential for biological growth. Lack of ready availability of any component essential to growth reduces the rate of reproduction of an organism or rate of growth of the population. The presence of light at less than optimum magnitude or a nutrient concentration less than optimum may be "growth limiting" to algae.

Phosphorus levels of 0.01 mg/l have been considered growth limiting in Wisconsin Lakes [5-7]. Studies have shown growth rates to be reduced to one-half the maximum at 0.004 to 0.006 mg/l orthophosphate phosphorus [5-8]. Curves on Exhibit V-4 indicate that phosphorus would seldom be growth limiting below Spokane and particularly not during low-flow periods.

Cunningham and Pine [5-4] found orthophosphate phosphorus as low as 0.015 mg/l in epilimnion waters of Long Lake Dam Reservoir in September, 1966. The reduction from about 0.17 mg/l which was available in waters entering the reservoir may have been caused by algal growth uptake, chemical precipitation, or both. The solubility of orthophosphate under conditions similar to those found is about 0.015 mg/l as P [5-9], indicating the measured concentration was established by chemical equilibria.

Algal yields in mg dry cells produced/mg P utilized have been reported at 805 [5-8], 650 [5-10], 240 to 290 [5-11], 30 [5-12] and 4 to 8 [5-13]. Other factors influence the quantity of algal cells grown per unit of phosphorus. A reduction in phosphorus input to the Spokane River may not reduce the algal production.

Condit [5-6] found no significant increase in algal yield with phosphorus additions to the river water, either up or downstream of the sewage treatment plant discharge. An increase in response rate was reported, indicating that the phosphorus added was probably in a more readily available form than that in the river.

Little data is available on nitrogen concentrations which limit algae growth but limiting values in the range of 0.01 to 0.25 mg/l have been reported [5-12, 5-13]. It appears doubtful from Exhibit V-5 that limiting levels are present anywhere in the Spokane River.

The question as to whether either nitrogen or phosphorus is or can be made a limiting nutrient in Long Lake Dam Reservoir is unresolved.

D. SUMMARY

1. The Spokane River bacteriological quality is lower than desirable. The greatest degradation occurs within the City of Spokane, upstream of the Spokane sewage treatment plant discharge. The treatment plant effluent does not appear to be adversely affecting the river bacteriologically.

2. The Spokane River suffers an oxygen deficiency in the lower reaches of and downstream from Long Lake Dam Reservoir. This problem is aggravated by the oxygen demanding suspended matter resulting from the Spokane sewage treatment plant effluent. The oxygen problem may be further aggravated by algal growth settling from surface waters of the impoundment into the deeper waters, but the relative contribution of each of these sources has not been delineated. The cause of stimulation of the algal growth has not been determined and no single remedy, such as nutrient removal from sewage effluents, is assuredly available at this time.

VI. EXISTING WASTEWATER CONTROL FACILITIES

A. COLLECTION SYSTEM

1. History

The sewage collection system in the City of Spokane is primarily a combined sewer system; that is, both sanitary sewage and storm water are conveyed in the same pipes. Some of the collector or main trunk lines are quite large. The first sewer line in Spokane was built in Howard Street from First Avenue to the River in June of 1889. The area from the base of the South Hill to the River between Cedar and Division Streets was sewered during the 1890's. Growth of the system paralleled that of the city throughout the years and the present system contains over 500 miles of sewer lines of various sizes. Pumping stations had to be installed as the city developed to overcome differences in elevation.

For many years the City had no treatment of its liquid wastes. In 1946, a bond issue was passed, and intercepting lines and transmission lines were installed to convey the sewage to a planned sewage treatment plant.

As the need arose, and sewage flows generated by the growing city exceeded capacity in the existing lines, relief sewers were installed to convey this excess further downstream to a point having sufficient capacity available in the pipes. Relief overflows were installed at critical points to divert a portion of the flow into a different line having capacity not being used.

2. Trunk Systems

For the purposes of this study, the City has been divided into ten major trunk systems or zones. These are delineated on Exhibit II-1.

Detailed data on the system, such as location and capacity of the trunks, interceptors, relief lines, lift stations and force mains, and unsewered areas are presented for each zone on Exhibits VI-1 through VI-7.

3. Lift Stations

Sixteen separate lift stations are operated by the City in the sewage collection system. The majority pump only domestic or sanitary sewage, but many are forced to pump combined sewage and are protected from flooding by an overflow device. A brief description of these lift stations is given in Table VI-A. These are located on Exhibits VI-1 through VI-7.

There are five known, privately owned and operated lift stations serving the Riverview Convalescent Center, the Washington Water Power Company building, Gonzaga University, Crystal Laundry and Manito Golf and Country Club. They all discharge to the city collection system.

4. Relief Sewers

Relief sewers have been installed in certain sections of the city to convey

TABLE VI-A

No.	Location or Name	Capacity	Sewage	Point of Discharge	Area Served Or Comment
1.	Springfield Station		Sanitary	Main Interceptor	Springfield Dist. (New Sta.)
2.	Assembly & Francis	2-300 gpm	Combined	Collection System	Francis & Assembly
3.	Francis & Cannon	3 pumps & Standby mech.	Sanitary	Collection System	Cannon Bowl Area
4.	Panorama Terrace	Dual Pneumatic Package	Sanitary	Lagoon	Five-Mile Prairie
5.	Continental City	2-300 gpm package - mechanical	Sanitary	Collection System	Continental City Area
6.	N. Ferral Street	2-750 gpm package - mech.	Sanitary	Collection System	N. E. Area
7.	Ferris High School	2-300 gpm Submersible	Sanitary	Collection System	Ferris High School Area
8.	45th & Regal	2 Submersible	Combined	Collection System	Local Area
9.	46th & Cook	2 Submersible	Combined	Collection System	Overflows during Storms
10.	35th & Helena	2 Pneumatic 2-600 gpm mech.	Sanitary Storm	Collection System	Local Area Local Area
11.	36th & Bernard	Single Pneumatic	Combined	In Line	In Line Booster (Very Old)
12.	Clarke & Linton	2,700 gpm Total Mech. Standby	Combined	Main Interceptor	S. W. Area
13.	Elm Street	2-400 gpm Mechanical	Combined	Branch Interceptor to Clarke Street	Pleasant Valley Area
14.	San Souci West	2-150 gpm Mechanical	Sanitary	Collection System	"Natatorium Park" Area
15.	SFCC	Dual Pneumatic package	Sanitary	To siphon across river	Possibly some storm water
16.	Rivercrest Hospital	Dual Pnem. Pkg.	Sanitary	Interceptor	Hospital Only

excess flow past a section of sewer which has insufficient capacity. Some of these convey the sewage to the interceptor sewer, and others simply convey it far enough downstream to reach a pipe of sufficient capacity. A brief description of major relief lines follows:

a. 36" pipe in Broad Street from Driscoll Boulevard to Assembly. Serves area bounded by Rowan on the south to Francis on the north and from Wall Street on the east to "A" Street on the west. Appears on Exhibit VI-7.

b. 30" pipe in Perry Street from 17th to Newark and in Denver Street from Newark to Liberty Park. Serves area bounded by 17th on the north to 29th on the south and from Rockwood Boulevard on the west to Crestline on the east. Appears on Exhibit BI-2.

c. Line varying in size from 15" to 24" in diameter starting in Rockwood Boulevard near Sacred Heart Hospital; ending at Sixth and Stevens. Serves business area immediately to the south and west of Sacred Heart Hospital. Appears on Exhibit VI-3.

d. 36" pipe starting at 42nd and Garfield to Hatch and High Drive; pipe is in side of hill from Hatch and High Drive to 29th and High Drive. Size changes to 42" approximately 1,000 feet west of intersection of High Drive and Bernard. This line has a storm overflow to Latah Creek at approximately 38th and High Drive. Serves area bounded by 33rd on the north to 44th on the south and Perry on the east to Division on the west. Appears on Exhibit VI-3.

e. 66" pipe starting at Hartson and Regal ending at Front and Erie. Serves southeast part of city from city limits on the south to Burlington Northern Railroad on the north and city limits on the east to Crestline on the west. Appears on Exhibit VI-2.

5. Interceptor System

An interceptor system was installed during the period from 1948 to 1958, when the treatment plant was first placed in operation. The system has since been enlarged and extended. This system of interceptor sewers is designed to receive the dry weather flow, plus a portion of the storm flow from the city's trunk sewers, and to convey this flow to the sewage treatment plant. Available records indicate that the interceptor system was initially designed to carry 2.3 times the average dry weather flow based on a future population of 258,000 people. The interceptor system is shown on Exhibits VI-1 through VI-7.

6. Storm Sewer Systems

In some sections of the city storm sewer systems have been installed. These areas are, in general, the newer or more recently developed areas of the city. The systems are shown on Exhibits VI-1 A through VI-7A. The storm systems were installed to provide a complete separation of storm and sanitary sewage within the area served. They usually contain larger pipe than the sanitary system, collect the flows from catch basins and some roof drains, and exclude any flow from the sanitary sewers. Some areas have a storm outfall directly to the Spokane River, while other areas farther from the river discharge the storm flow into a combined sewer. Many of the latter have received sanitary connections since being put in service and now function as combined sewers.

7. Unsewered Areas

Principal unsewered areas lie in the northeast, east central and southeast sections of the city near the city limits. These are delineated on Exhibits II-3 and VI-1 through VI-7. An estimated 2,450 homes are not presently connected to available sewers. These homes are scattered throughout the older areas of the city.

8. Existing Sewer Capacities

The existing collection system was subdivided into ten zones, containing 63 service areas. Capacity of both sanitary and storm sewers was calculated for each individual service and surface drainage area. The capacity of major trunks, interceptors and relief sewers is shown on Exhibits VI-1 through VI-7. Capacity calculations for other lines are on file with the City of Spokane.

B. SEWAGE TREATMENT PLANT

In May, 1958, the first phase construction of the existing sewage treatment plant was placed in operation. An expansion and modification program in 1961-62 placed the plant at its present capacity. Exhibit VI-8 shows a layout of the sewage treatment plant with the schematic flow routing. The pre-aeration tanks, one of the four clarifiers, two of the four digesters and 50 percent of the chlorine contact tank capacity were added during this treatment plant expansion.

The City of Spokane Sewage Treatment Plant provides primary treatment to dry weather sewage flows. During wet weather a portion of the combined sanitary sewage and runoff water overflows to the river at various points within the sewer system, and also at the entrance to the sewage treatment plant.

The capacity of the main interceptor sewer where it enters the sewage treatment plant is 110 mgd, while the capacity of the Hollywood interceptor, serving Zone X, is about 15 mgd. The maximum flow that can arrive at the plant is 125 mgd.

The plant downstream of the influent flow structure has a design capacity of 50 million gallons per day (mgd). Wet weather flows in excess of approximately this amount are diverted to the river through the overflow bypass. The amount diverted is not metered. Exhibit VI-9, Figure 1, shows the average annual flow through the sewage treatment plant from 1960 through 1971 and the average flow during the maximum month of each year.

All information on Spokane sewage treatment plant loading and performance presented herein was obtained or calculated from sewage treatment plant reports supplied by the City of Spokane.

From the influent control structure the treatment plant influent passes through a comminuting screen and into two parallel aerated grit removal chambers. After grit removal, the flow is aerated for 35 minutes at design flow prior to primary clarification. Primary clarifiers are designed at 1,000 gal/sq ft/day overflow rate and two hour detention time. The primary effluent is chlorinated, then passes through the chlorine contact tanks to the river [6-1].

Most of the solids retained on the comminuting bar screen are chopped sufficiently fine to pass through and into the treatment plant. Large rags, boards, etc., are removed by hand and disposed of at the city's sanitary landfill. Sand and rocks accumulate in the influent control structure and are periodically flushed to the river. Grit accumulated in the aerated grit chambers is automatically removed for trucking to landfill disposal. A little more than 1/2 cubic yard of grit was removed per day in 1971. The pre-aeration chambers have facilities for floatable oil and grease removal. Remaining floatable oils and grease are skimmed from the clarifier surfaces and disposed of with clarifier underflow solids.

The clarifiers remove suspended solids from the wastewater flow by settling, and the solids are in turn removed from the clarifier bottom in a constant flow of water at a concentration of about 0.3 percent solids. This "sludge" flow goes to two thickeners where it is again settled with the underflow going to the digesters at from 6 to 7 percent solids. Following anaerobic digestion, the solids are dewatered on two vacuum filters to achieve a "cake" containing 25 to 30 percent solids for disposal in a landfill.

1. Plant Performance

The objectives of the Spokane Treatment Plant are:

a. To remove aesthetically displeasing gross sewage solids.
b. To enhance river water clarity by reducing the quantity of total suspended solids discharged.
c. Reduce the oxygen demand by the amount contained in the removed suspended solids.
d. Reduce the floatable oil and grease content.
e. Disinfect the effluent to reduce the hazard of disease transmission by sewage-contained pathogenic organisms.

The Spokane treatment plant adequately removes gross sewage solids except during overflow and bypass operation.

Exhibit VI-9, Figure 2, shows the average annual suspended solids concentration in the influent and effluent from the sewage treatment plant. Neither concentration appears to change significantly throughout the period. Influent and effluent 12 year average concentrations are 132 and 53 mg/l respectively for an average removal of 60 percent. Suspended solids averaged 72 percent volatile over the 12 year period.
Biochemical oxygen demand (BOD, 5 day) concentration in the influent and effluent from the sewage treatment plant is shown in Exhibit VI-9, Figure 3. There is apparently little significant long-term change in the treatment plant influent BOD concentration and the 12 year average is 141 mg/l. However, the effluent BOD appears to show a definite decreasing trend, with a pronounced decrease just following the plant expansion in 1962. The removal efficiency for BOD was markedly improved at the time of the treatment plant expansion as shown in Exhibit VI-9, Figure 4. BOD removal averaged 60 percent through primary treatment over the last six years. The suspended solids removal efficiency underwent no corresponding increase. This implies that the principal value of the plant expansion was in the preaeration step where the retention under aerobic conditions allowed the bacteria to synthesize soluble BOD into suspended solids which flocculate and are removed in the clarifiers. Further evidence of this is shown on Exhibit VI-10, Figure 5, where the amount of sludge removed showed a marked increase at the time of the plant expansion and followed a rather level course thereafter. An average solids balance from January, 1970, through January, 1972, shows about 0.7 lb. of solids were generated per lb. of BOD removed. This figure indicates that some biological treatment is apparently occurring in the pre-aeration clarification system. The average 60 percent BOD removal being obtained by this treatment plant is somewhat better than normally expected from primary treatment facilities.

Oil and grease concentrations have not been monitored; thus the amounts removed are unknown.

Disinfection of the treatment plant effluent during 1967 through 1971 has reduced median coliform values to 3,100, 2,900, 6,600, 2,000, and 2,900 per 100 ml, respectively. Influent values varied from 10 million to 100 million per 100 ml, which means that greater than 99.9 percent removal was obtained. Residual chlorine was controlled by manual adjustment at 0.4 mg/l in the contact tank.

3. Current Plant Loadings

Exhibit VI-10, Figure 6, shows the average daily flow and the average daily maximum and minimum flows on a monthly basis for 1970, 1971, and part of 1972. The average daily flow during this period was 28 mgd. The average daily maximum flow was 1.4 times this figure, 39 mgd, and the average daily minimum was 0.6 times the average daily or 17 mgd. Exhibit VI-10, Figure 7, shows a typical weekday dry weather diurnal flow variation.

Exhibit VI-11, Figure 8, shows the quantity of suspended solids in the plant influent and effluent on a monthly average basis. There is little trend during the two years of record shown. The maximum daily suspended solids load each month is also shown and displays a considerable amount of variation due to the influence of runoff flows. Based on plant records the loading on the primary digesters is about 0.154 lb. of volatile solids per cubic foot per day. This is near the upper limit for reliable operation.

Exhibit VI-11, Figure 9, shows the quantity of BOD in the raw sewage entering the sewage treatment plant and in the primary effluent on a monthly average basis. There appears to be a slight upward trend in both sets of values over the two-year period. The maximum day BOD values for each month are also shown and exhibit variations similar to those for suspended solids.

4. Treatment Plant Deficiencies

The Spokane Sewage Treatment Plant is operating as efficiently as can be expected for a facility of its type and characteristics. There are no provisions for the plant to handle the magnitude of wet weather flows conveyed to the site by the interceptor sewer system. The operating personnel must allow a portion of the flow to bypass the plant during wet weather periods. The grit removal and handling facilities are inadequate under certain conditions. The chlorine contact facilities are inadequate according to present design standards.

As the present State of Washington requirements call for secondary treatment of Spokane's sanitary sewage, the plant is also deficient in that only primary treatment is provided.

VII. HYDROLOGY AND SEWAGE FLOWS

A. GENERAL

Hydrology is the study and science of water, its properties, laws and distribution. While the properties and laws specifically relating to water are well defined, hydrology as a weather related event is not an exact science. This chapter presents the precipitation-runoff relationship established during this study and its application with lont term weather records to estimate runoff characteristics for Spokane. Runoff was used in determining peak sewage flows and overflow occurrence to allow development of control alternatives. When dealing with weather related events, statistical averages must be used, combined with the best information and judgment available to result in adequate and economical facilities.

B. PRECIPITATION

Weather records for Spokane, available through the U. S. Weather Bureau, cover a period of more than sixty years. The official U. S. Weather Station was located in downtown Spokane at the U. S. Post Office until December, 1947, when it was relocated to Spokane International Airport.

Three recording rain gauges were established during this study to affirm that precipitation in Spokane was not significantly different from that at the airport. Location of these gauges is shown on Exhibit VII-1. Exhibit VII-1 also shows mean monthly precipitation and rainfall intensity-duration-frequency curves.

C. RUNOFF

In order to relate precipitation to system flows and overflows, it was necessary to measure overflow at selected locations to determine permeability factors based on land use characteristics and to develop coefficients for use in calculating runoff.

1. Study Limitations

Limitations to a complete analysis of runoff in Spokane were observed during this study.

a. It was not practical to monitor and meter all points of interception and overflow. A limited number of monitoring points were selected to cover a range of conditions. Principal locations for flow monitoring devices are shown on Exhibit VII-1.

b. The data collection period to correlate precipitation to runoff was one year. During the winter months of November through March there was no consistent time-volume relationship between precipitation and runoff as much of the precipitation occurred as snow.

2. Precipitation - Runoff Correlation

A relationship between precipitation and runoff was obtained based on recorded data for several storms in each of the areas monitored. The correlation between precipitation and runoff is shown on Exhibit VII-1. Runoff was determined from monitored sewage flows and is expressed in inches based on the impervious area. Precipitation was determined from the recording rain gauges.

The regression line intercept was established from studies in other areas where runoff occurred only when total rainfall exceeded 0.03 inches [7-1]. The slope of the regression line is 0.7 for the rainfall-runoff correlation plot.

The rainfall-runoff correlation was 0.7 for impervious areas in Spokane.

3. Runoff Calculations

Runoff flows were calculated utilizing the rational formula:

$$Q = c\ i\ A$$

Where Q is the peak runoff flow,

i is the rainfall intensity from the intensity-duration-frequency curves on Exhibit VII-1,

A is the area drained, and

"c" factors were determined as the product of the rainfall-runoff correlation, 0.7, and the impervious area value for each locality.

The impervious area value was evaluated in detail for each basin prior to calculation of actual "c" factors used during this study. Impervious area values for various typical urban areas [7-2, 7-3] and calculated "c" values are as follows:

Land Use	Impervious Area Value	"c" Factor
Commercial areas	0.9 - 1.00	0.63 - 0.70
Industrial Areas	0.3 - 0.50	0.21 - 0.35
Residential Areas	0.15 - 0.30	0.11 - 0.21
Schools	0.05 - 0.10	0.04 - 0.07
Parks	0.0 - 0.05	0.0 - 0.04
Undeveloped	0	

"c" factors were determined as the product of the rainfall-runoff correlation found above, 0.7, and the impermeability factor for each locality. These were then composited and used in the rational formula to calculate runoff from individual service areas.

D. SEWAGE FLOWS

Sewage flows were calculated for trunk and interceptor sewers. They are presented on Exhibit VII-2.

1. Dry Weather

Sanitary or dry weather flow was calculated by using population data and an average per capita contribution for each service area. Service area flows were combined to produce a total contribution from each trunk zone. Flow measurements were made at representative locations throughout the system to verify calculated flows. Trunk zone contributions were then accumulated to produce the peak sanitary or dry weather flow arriving at the treatment plant. This calculated flow satisfactorily compared with the treatment plant flow recordings.

2. Wet Weather

Wet weather or storm flow was calculated for each drainage basin using the rational formula. Calculated peak storm and peak sanitary flows were added to determine the peak combined flow in the sewer. Flows were accumulated in the sewers to the limit of the pipe capacity and are presented on Exhibit VII-2. Overflow weirs and connecting pipe capacities were also limiting factors and peak trunk flow in excess of either of these was the calculated peak overflow. Peak flows were accumulated in the interceptor based on existing conditions.

E. OVERFLOW OCCURRENCE

1. Number and location of overflows

a. The collection system contains 49 overflow structures.

b. Overflow from four of these structures discharges to another trunk sewer and relieves trunkline surcharges.

c. Discharge from 45 of the 49 structures leaves the sewer system.

d. Some of the points of overflow discharge to common overflow outfalls, resulting in only 31 separate outfall lines to the river.

e. There are 45 overflow points, including the sewage treatment plant overflow bypass, through which untreated sewage may be discharged directly to the Spokane River.

The location of the 45 overflow points is shown on Exhibit II-2.

2. Frequency, Magnitude and Duration

The relative significance of each of the 45 overflow points depends on the total amount of untreated sewage lost during overflow occurrences. Evaluation was based on calculations validated by field measurements.

Two methods of evaluation were used to convert precipitation records to overflow frequency magnitude and duration relationships.

a. The method used primarily during this study utilized a composite hyetograph developed from the U. S. Weather Bureau records at the Spokane Station for the years 1961-1970.
Exhibit VII-3 shows the composite hyetograph and the method used to calculate frequency, magnitude and duration relationship for the overflow points.

b. The method for verification of overflow characteristics involved developing unit hydrographs from runoff records collected during the sampling period April to October, 1971 [7-4 and 7-5].

Eighteen storm hydrographs obtained in the City of Spokane were prepared in a dimensionless form and plotted with Commons dimensionless hydrograph [7-4] on Exhibit VII-1. Commons dimensionless hydrograph appears to be applicable for use in the City of Spokane.

Exhibit VII-4 presents a schematic diagram of overflow points and a tabulation of the overflow frequency, duration and volume for an average year.

VIII. COLLECTION SYSTEM INADEQUACIES

A. OVERFLOWS

The following overflow points do not, or cannot, function in a satisfactory manner, shown on Exhibit II-2.

1. The overflow chambers at Front and Erie, Overflow Points No. 9, 10, and 14, and the overflow chamber at Mallon and Perry, Overflow Point No. 8, were constructed below the river high water level and permit the river to enter the interceptor at high river stage. To prevent this, gates were installed at the intercept connections. Closing of these gates forces continuous raw sewage discharge during the period of high river stage each year.

2. Three intercept chambers were found in which the weir overflowed peak sanitary sewage to the river. These are located at Sharp and Perry, No. 6; Cochran and Grace, No. 36; and Northwest Boulevard and Assembly, No. 40. This information was furnished to the city at the time of discovery.

B. CENTRAL BUSINESS DISTRICT (CBD)

A television inspection of the CBD sewers was conducted during June, 1971, to determine the physical condition of these lines, which are among the oldest lines in the city. Over 150 individual points requiring remedial action were recorded during the inspection.

The most critical points include collapsed lamp holes and broken or collapsed pipe. The bottom was gone from some sections of the pipe. The "old downtown line" should be replaced.

C. IN-SYSTEM DEFICIENCIES

A study of Spokane's collection system revealed numerous in-system deficiencies. These are, generally, cases of insufficient line capacity to convey the flows generated. Most are simply a result of extending service beyond the ability of the trunk line to convey the additional flow of storm water. Service is satisfactory for sanitary flows during dry weather.

1. Trunk line capacity is exceeded at the following locations:

   a. The trunk main system from above Stevens and Indiana downstream to the point of interception on Division Street;

   b. The trunk main in Assembly Street;

   c. The sub-mains in Addison, Nevada and Perry; and

   d. The three siphons under Latah Creek which convey flow from the southwest area and Spokane International Airport.

   Surcharges develop in all of these lines during moderate storm conditions and produce localized surface ponding. Locations where these conditions exist to a lesser degree and ponding occurs during more intense storms are 16th at Grand and 25th at Grand.

2. Locations where the connection to the interceptor lacks sufficient capacity to convey intercepted flows are:

   a. Cochran and Grace, No. 36. The siphon connection has capacity to convey only peak sanitary flows;

   b. Hartley at Northwest Boulevard, No. 42;

   c. The interceptor in Linton from Riverside and "A" to the Clarke Street Pumping Station;

   d. The 24 and 27 inch intercepting siphon from Howard to Lincoln on the north side of the river.

3. The main interceptor immediately upstream from the Post Street Bridge when surcharged will:

   a. Create surcharge sufficient to force an overflow at Lincoln and Trent, No. 18; and

   b. Force an overflow through a 10 inch under drain discharge from the interceptor manhole at Post and Trent to the overflow line from Lincoln and Trent.

IX. WASTEWATER QUALITY

A. SANITARY SEWAGE

The sanitary sewage from Spokane is defined as that arriving at the sewage treatment plant during dry weather, or when no surface runoff is entering the system. As this is the case during a majority of the time, the quality averages as recorded on the sewage treatment plant records are considered as representative of the sanitary sewage flow.

The suspended solids (SS) content of Spokane's dry weather sewage flow on an annual average basis was plotted on Exhibit VI-9, Figure 2, for 1960 through 1971. It was seen to fluctuate little from the twelve year average of 132 mg/l. The dry weather BOD (5 day) concentration of Spokane's sewage averaged 141 mg/l over the twelve years, as plotted on Exhibit VI-9, Figure 3. The analyses were run on twenty-four hour composite samples.

Over a twelve month period, February, 1971, through January, 1972, the BOD averaged 146 mg/l and had a standard deviation of 46 mg/l for 87 analyses. The maximum monthly average was 203 mg/l during October, when the standard deviation was 51 mg/l for six samples.

Coliform bacteria concentrations (MPN) of the raw sewage for Spokane is normally in the range of 10 million to 100 million per 100 ml, with the median approximately 28 million. This is a typical range for untreated municipal wastewater.

The nitrogen and phosphorus (P) content of Spokane's sewage has been monitored from June, 1971, through February, 1972. Periodic analyses were performed by a commercial laboratory on twenty-four hour composite samples. The results are shown in Table IX-A as the mean and standard deviation of the influent and the effluent concentrations, along with the number of analyses. About 10 percent of the phosphorus is removed by the primary treatment, but there is no significant difference in total kjeldahl or ammonia nitrogen (TKN or NH_3) values between influent and effluent samples. Nitrate nitrogen (NO_3) was negligible in the wastewater.

TABLE IX-A

SPOKANE SEWAGE--NITROGEN AND PHOSPHORUS CONTENT

June, 1971, through February, 1972

Constituent	Mean Concentration mg/l	Standard Deviation mg/l	No. of Samples
Total phosphorus--influent	6.0	1.9	39
Total phosphorus--effluent	5.5	1.2	24
Total kjeldahl nitrogen--influent	19.8	3.6	19
Total kjeldahl nitrogen--effluent	20.1	4.8	11
Ammonia nitrogen--influent	10.9	2.8	11
Ammonia nitrogen--effluent	10.8	3.2	11

In addition to these measured constituents average municipal sewages contain about 2.2 units of fish toxicity [9-1] and about 30 mg/l of oil and grease, hexane extractable materials. Some heavy metals and other constituents may also be present.

B. RUNOFF

The surface runoff from Spokane is similar to that of typical U. S. cities, in that it contains substantial amounts of suspended solids, mostly inorganic, a moderate amount of BOD, floatable detritus and floatable oils and greases washed from roadway surfaces.

Runoff water quality was spot checked at several points during this study. Grab samples from the storm sewer at Nine Mile Road and Assembly Street were analyzed. They contained:

6/2/71	BOD = 14 mg/l	P = 0.26 mg/l	TKN = 1.5 mg/l
8/22/71	BOD = 41 mg/l	P = 0.35 mg/l	TKN = 23.6 mg/l
		SS = 100 mg/l	VSS = 58 mg/l

The storm sewer at Superior and Cataldo was monitored on July 30, 1971, for runoff quality at various times after the beginning of the storm on that date. The results are plotted as Curve 4 on the figures contained in Exhibit IX-1. These curves show that peak concentrations of the constituents measured occur early in runoff, indicating the "first flush" clearing of accumulated constituents from catch basins and sewer lines. First flush concentrations are probably highest following relatively long dry periods, when greater accumulations of constituents occur.

Items 1 through 12, Exhibit IX-2, show runoff water quality from several studies. An extreme variation in runoff quality can be seen from each entry. Some seasonal variation was noted in the Cincinnati study with winter-spring suspended solids levels averaging 50 percent greater than in summer-fall.

Similar observations from the Washington, D. C., study and this study showed peak concentrations occurred during first flush periods of runoff. The same pattern was observed in Cincinnati where SS averaged nearly 400 mg/l, BOD nearly 50 mg/l, COD about 170 mg/l, and TKN about 3.6 mg/l during the first 15 minutes of runoff, significantly higher than the overall averages. The runoff data consistently showed high suspended solids (SS) concentrations, with averages at or exceeding the concentration of sanitary sewage. Volatile suspended solids (VSS) generally average lower than found in sanitary sewage as the percent volatility is much lower at about 30 percent. The average BOD of urban runoff averages less than half the concentration of sanitary sewage, but first flush concentration may approach that in sanitary sewage flow. Chemical oxygen demand (COD) concentrations seem to be about the same relative to sanitary sewage as BOD. Total kjeldahl nitrogen (TKN), organic plus ammonia nitrogen, in runoff waters, appears to average only about 20 percent of the concentration in sanitary sewage while total phosphorus (P) concentrations appear to average about 10 percent.

No oil and grease data was available from the present Spokane study or in the literature but runoff from street and parking areas undoubtedly contain automobile drippings. Detritus, such as paper and plastics, enter storm runoff waters, but have not been quantitated.

Runoff waters contain coliform type bacteria, although they normally originate from other than human sources. The runoff water coliform level (MPN) appears to average about 100,000 per 100 ml.

Catch basin samples were collected after extended dry periods and analyzed. The results were as follows:

Columbus and Baldwin	6/30/71	BOD = 441 mg/l	MPN = 240,000/100 ml
Lincoln and Riverside	7/8/71	BOD = 765 mg/l	MPN = 46,000/100 ml
Jefferson and LaCrosse	7/8/71	BOD =1800 mg/l	MPN = 240,000/100 ml
8th and Jefferson	8/9/71	BOD = 78 mg/l	MPN=1,100,000/100 ml
			SS = 288 mg/l

These results indicate why the runoff strength is quite high, as it is during the first flush period when the catch basin contents are displaced into the sewer system. Surface accumulations washed into storm drains during early parts of storms also contribute to first flush higher concentrations. Catch basin elimination will alleviate the first flush increased concentration of constituents.

Based on the data gathered during this study and the results of other studies, representative averages for runoff concentrations in Spokane were selected as follows:

BOD = 50 mg/l SS = 260 mg/l TKN = 4 mg/l Total P = 0.5 mg/l

C. COMBINED SEWAGE

The major portion of Spokane's sewer system is combined, or accepts flows both from connected sewers and from surface runoff. Under existing conditions, combined sewage may contain from 80 percent down to 10 percent or less of sanitary sewage.

Curves 1, 2, 3, 5 and 6, in figures on Exhibit IX-1, show the results of sampling combined sewage overflows during this study. The curves indicate the first flush high concentration runoff effect followed by the diluting effect of the storm water on the sanitary sewage. Data on combined sewage overflows obtained in other studies is presented as Items 13 through 17 on Exhibit IX-2. The average effect of runoff water entering sanitary sewage appears to be dilution to a lower BOD, increased suspended solids and lower TKN and P concentrations. First flush flows result in greater suspended solids and BOD concentrations in the combined sewage early in storms.

Other samples of combined sewage collected during this study were as follows:

Location	Date	BOD mg/l	SS mg/l	VSS mg/l	P mg/l	TKN mg/l
Cochran & Grace	5/31/71	32				
Dalton & Division	6/2/71	56	94	26	1.4	7.2
Meenach & Downriver	6/2/71	49	182	32	1.1	6.9
Meenach & Downriver	6/2/71	54	137	35	1.1	7.9
Riverside & Bernard	6/10/71	37	76	14	0.95	5.0
7th & Inland Empire Way	7/9/71	164				

The influence of the storm water can readily be seen by the BOD, TKN and P dilution and also by the volatile solids content, which is considerably lower than 72 percent sewage treatment plant average.

X. EMISSION OF WASTEWATER CONSTITUENTS

The total annual emission of wastewater constituents is probably the best indicator with which to judge the effects improved treatment facilities and overflow correction will have on the water quality of the Spokane River.

A. QUANTITY OF PRESENT EMISSIONS

The annual emission of flow, suspended solids, biochemical oxygen demand, total kjeldahl nitrogen and phosphorus from the Spokane sewer system are shown on Table X-A. The annual runoff and overflow quantities are those computed in Chapter VII, while sanitary sewage emissions were taken from treatment plant records presented in Chapter VI, and quality records presented in Chapter IX. Runoff water characteristics were presented in Chapter IX. Overflows were considered as proportioned mixtures of sanitary sewage at its average strength and the assumed runoff concentrations. Combined sewer overflows shown on Table X-A do not include quantities bypassed at the sewage treatment plant.

TABLE X-A

ANNUAL EMISSION RATES FROM THE SPOKANE SEWER SYSTEM

	Flow Million Gallons	SS Thousand Pounds	BOD Thousand Pounds	TKN Thousand Pounds	Thousand Pounds
Raw Sewage Flow[1]	10,200	10,700	12,200	1,700	510
Primary Effluent[1]	10,200	3,760	5,290	1,700	470
Total Runoff	1,500	3,300	620	50	6.3
Combined Sewer[2] Overflows	740	1,400	430	46	10.5
Sanitary Sewage in[2] Overflows	160	170	190	27	8
Sewage Flow after Secondary Treatment	10,200	1,070	1,830		
Overflows after Primary Equivalent Treatment	740	700	300		

1. 1970 - 1971 average at Spokane Sewage Treatment Plant.

2. Computed based on assumption that interception capacity = 2 x dry weather flow

Table X-A shows that on an annual basis, runoff waters contain negligible amounts of the nutrients, nitrogen and phosphorus, compared to the sanitary sewage flow. Runoff waters contain approximately 10 percent as much BOD as the treatment plant effluent. System overflows contain less than 8 percent as much BOD as the sewage treatment plant effluent. Runoff waters carry nearly as much suspended solids as are discharged to the river annually in the treatment plant effluent. Those carried in the runoff are more inert, however, consisting primarily of sand and grit.

The short term problems created by overflow may be of more importance than the annual emissions, as transient reductions in water quality then occur. Exhibit VII-1 shows storm runoff frequency for Spokane. From this figure, a runoff rate of about 600 cfs can be expected one hour each year. A one-hour flow at this rate would discharge about 17 tons of suspended solids to the river and nearly 4 tons of BOD. If the river were flowing at 1,000 cfs entering Spokane, this amount of runoff evenly mixed would provide nearly 100 mg/l of suspended solids and 20 mg/l BOD.

Runoff amounting to 300 cfs can be expected about eight times each year for a one hour duration. This runoff would discharge 8 tons of suspended solids and 1 1/2 tons of BOD during one hour. This would provide about 60 mg/l SS and 10 mg/l BOD to the river, assuming the same discharge and mixing.

B. EMISSIONS FOLLOWING INSTALLATION OF IMPROVEMENTS

1. Secondary Treatment

The addition of secondary treatment facilities and facilities sufficient to eliminate bypassing at the sewage treatment plant would reduce the suspended solids and BOD emissions from this source by about 70 percent and 65 percent respectively. This step would reduce total annual emissions of suspended solids and BOD from all sources by 50 percent and 61 percent, respectively.

2. Overflow Treatment

The equivalent of primary treatment for overflow would reduce suspended solids by 50 percent and BOD by 30 percent from this source. This step would reduce total annual emissions by about 30 percent and 5 percent, respectively, following installation of secondary treatment for sanitary sewage. The release of esthetically undesirable gross solids in overflows would be controlled by these facilities.

3. Sewer Separation

Separation of sewers throughout the city, assuming the treatment plant were upgraded to secondary treatment, would increase the quantity of suspended solids discharged to the river by about 80 percent, while BOD would be increased by about 10 percent. The release of esthetically undesirable gross sewage solids would be corrected by separation. Contamination of river waters by the sanitary sewage bacteria contained in combined sewer overflows would be eliminated.

XI. CONCEPTS FOR ALLEVIATING STORM WATER OVERFLOW PROBLEMS

The undesirable aspects of combined sewer overflows have been discussed. The principal objection to their occurrence is that they carry untreated sanitary sewage directly into the river.

Three alternatives were evaluated for consideration. Separation of storm and sanitary sewers would alleviate this problem as the sanitary sewage interception and treatment systems would then collect and treat all sanitary flows and not be hydraulically inundated by runoff waters.

The installation of interceptor sewer and main treatment plant facilities of sufficient capacity to accept the hydraulic loads presented by the combined sewer system would assure treatment of all sanitary sewage prior to release, and also provide treatment for the runoff waters.

A third alternative for mitigating the release of raw sewage would be installation of separate and individual treatment facilities for individual or groups of overflows at the point of discharge.

These concepts and their application to the overall problem and to individual areas are discussed in this chapter.

A. SEPARATION OF SEWERS

Providing separate systems for the collection of sanitary sewage and runoff would alleviate the problem of untreated sanitary sewage escaping to the river, as the interceptor will handle about double the present peak sanitary flows. The separation of sewers would be an expensive and time-consuming project. It could be accomplished by constructing a new parallel collection system. The new system would be designed to accept either the runoff flows or sanitary flows now going into the combined system. Cost of installation would be comparable whether the new sewers were sanitary or storm.

The cost of a separate system has been estimated for several cities in recent years. In 1958, the cost of separation for Seattle was estimated at about $4,000 per acre [11-1]. More recent reports from Chicago, Detroit, and Philadelphia [11-2, 11-3, 11-4] have estimated costs at about $20,000 per acre. Based on $5,000 per acre, it would cost about $100,000,000 to provide separate sewers throughout the approximately 20,000 acres presently served by the combined system. Much greater costs could be incurred if the prices quoted for eastern cities are indicative.

Sewer separation for the entire city would necessarily be phased over a number of years. Initially the major trunk mains to serve the several areas of the system would be installed with separation of individual drainage areas in subsequent steps.

B. INTERCEPTION AND TREATMENT OF COMBINED SEWAGE FLOWS

The discharge of untreated sanitary sewage in combined sewage overflows can be mitigated by installation of interception capacity to convey all flows to the main treatment plant site and the installation there of sufficient treatment capacity to handle the sanitary plus runoff flows. According to the figure showing storm runoff frequency on Exhibit VII-1, an interception and treatment capacity of 600 cfs, 400 mgd, plus dry weather sanitary sewage design flow would be necessary to reduce overflows to about one hour per year. A conduit 10 feet in diameter would be required to transport this flow and is estimated to cost $20,000,000. A secondary treatment facility for this flow would approach $50,000,000 in cost. The extreme flow fluctuations would make treatment reliability unpredictable. A capacity of about 900 cfs, 600 mgd, plus dry weather design flow would reduce overflow to about one hour in five years and would require a proportionately larger expenditure.

Interception could be accomplished by providing a somewhat smaller interceptor sewer, and storage tanks to accept the peak flows above the interceptor capacity. The stored flow would then be pumped back into the system as runoff flows subsided sufficiently to provide available capacity. Based on the existing interceptor capacity, a minimum storage capacity of 44 million gallons would be required to reduce overflows to an average of one hour per year, while at least 95 million gallons capacity would be required to reduce overflows to one hour per five years. A treatment plant with a capacity equal to that of the main interceptor plus the Hollywood interceptor 125 mgd, would be required to treat the discharge. A biological secondary treatment plant of this size would cost about $20,000,000. The storage facilities would have to be judiciously spaced throughout the system for maximum effectiveness. Based on an average cost of $300,000 per million gallons for storage, the cost of storage to reduce overflows to about one hour per year would be $13,000,000 while storage to reduce overflows to about one hour each five years would be $29,000,000. Operational unknowns and aesthetic considerations severely limit application of this concept.

C. TREATMENT OF COMBINED SEWAGE OVERFLOWS

A method for mitigating the effects of combined sewage overflows is to treat individual overflows prior to their discharge to the river. This treatment must be physical or physical-chemical in nature as a continuous feed would not be available to sustain a biological process. The design of a treatment facility to control the undesirable contents of combined sewage overflows should be directed toward the following priorities:

1. Removal of gross suspended solids, especially those of sanitary sewage origin.
2. Disinfection to reduce the levels of enteric bacteria.
3. Suspended solids removal to maintain water clarity during wet weather periods.
4. Removal of oils and greases to reduce slick formation on the receiving waters.
5. Removal of oxygen-demanding substances.

1. Recent Studies

The treatment of combined sewage overflows at the point of overflow has been the subject of several studies in recent years. A study of fixed screening in San Francisco [11-5] concluded that removal of coarse particles, fecal material, paper, leaves, and cigarettes was independent of screen aperture size over a range from 0.125 to 1.0 inch and that only marginal removal of BOD, oils and greases, and bacteria were accomplished. A study of high-rate, 86-143 gpm/sf, fine mesh, 74-167 micron, screening in Portland, Oregon [11-6] obtained about 30 percent suspended solids removal and 20 percent COD removal while experiencing concentrate flow of 10 to 30 percent the influent rate and a high incidence of screen failures. Indications were obtained, however, that the concentrate flow could be reduced to 10 percent and better screen life could be achieved by optimizing the design parameters.

A study of screening and disinfection of overflows in Philadelphia [11-4] achieved average suspended solids removals of about 50 percent using a 35 micron screen and 70 percent using a 23 micron screen, but data were quite scattered. Throughput rates of about 10 gpm/sf were used and concentrate flows were inadequately reported.

A Milwaukee, Wisconsin study [11-7] provided screening, 0.3 mm, and dissolved air flotation to combined sewage overflows. Their screen rate was 50 gpm/sf while flotation tank loading was 3 gpm/sf. Suspended solids, BOD, COD, and volatile suspended solids removals were all about 50 percent with standard deviations of about 15 percent without chemical addition. With chemical addition, suspended and volatile suspended solids removals were increased by about 15 percent while BOD and COD removals increased only slightly. Concentrated solids flows consisted of only about 2 percent of the inflow rate.

A test program in Washington, D. C., [11-8] utilizing chemical coagulation-flocculation followed by high rate filtration, 15 gpm/sf, on a fiberglass media achieved 90 percent average suspended solids removal with a range from 80 to 99 percent and BOD removals from 19 to 95 percent. Filtration on a tri-media filter got somewhat poorer performance at rates about 10 gpm/sf. A study in Richland, Washington, [11-9] also applied chemical coagulation followed by filtration on a tri-media filter, but additionally included activated carbon sorption in the process and achieved good results. The cost of construction for this treatment method would probably be over $200,000 per mgd capacity, while that for the process as tested in Washington, D. C., would probably exceed $100,000 per mgd.

2. Selection of Overflow Treatment Process

The removal of gross, esthetically displeasing suspended material can be accomplished by screening and total suspended solids load would also be reduced. This would vary according to type and mesh size of the screen used. Oxygen-demanding substances would be reduced by a quantity proportional to the suspended solids removal.

More complete solids removal and oil and grease removal could be achieved by dissolved-air flotation. To achieve secondary equivalent treatment, chemical precipitation and possibly sorption would be necessary additions. Disinfection could be accomplished by chlorination. Chlorination to high residuals without subsequent dechlorination is not recommended as excessive toxicity would be induced.

Fine screening followed by disinfection is proposed for overflow treatment to achieve equivalent primary treatment. A typical facility is shown schematically on Exhibit XI-1. The facilities would be constructed as a number of parallel treatment units to operate sequentially as the overflow rate increases. Design parameters for overflow treatment should be based on an evaluation of large-scale installations. A demonstration project is recommended for at least one year's duration, in which several types of overflow treatment processes are evaluated to provide data on treatment effectiveness, costs, and final design parameters.

Costs for individual overflow treatment facilities were derived from Figure XI-1. This figure was developed from curves presented by Smith and McMichael in FWPCA publication TWRC-9 for microscreening, and curves for chlorination presented by Robert Smith in JWPCF Volume 40 on page 1,560. These literature costs were increased by 30 percent to reflect cost changes in the time since they were prepared. There have been few determinations of operation and maintenance costs reported for overflow treatment installations. Estimates for O&M are presented in Section D of this chapter.

The overflow treatment facilities for Spokane should be limited to a relatively few by piping together overflows from several sites for treatment at a common location. Overflow treatment should not alter the City's policy of requiring separate sanitary and storm sewer systems for all developing areas.

Costs of sewers required for separation or overflow transport were based on the approximate length of pipe required. This was then multiplied by an estimated cost per lineal foot based on pipe size and judgment of the difficulties and complexity of construction in the individual area involved.

D. APPLICATION FOR INDIVIDUAL AREAS

This section contains discussions and preliminary cost estimates for alternatives to mitigate the individual overflows of combined sewage from the City's sewerage system. The discussion is divided into sections, each encompassing alternatives for handling one or more of the existing problem areas. The discussion proceeds from one discharge area to another beginning at the upstream end of the interceptor system and progressing downstream to the sewage treatment plant. (See Exhibit II-2). Alternatives for treating dry and wet weather flows at the treatment plant site are discussed in Chapter XII. The term treatment as applied to combined sewage overflows means fine screening and disinfection by chlorination. A schematic diagram for overflow treatment is shown on Exhibit XI-1.

1. Surro and South Riverton, Overflow Point No. 1 (Exhibit VI-1)

This overflow point is located in a large open area near the eastern edge of the City and just west of Felts Field. Space is available to implement any concept considered. The area could also provide a site for a future treatment plant to serve the Moran Prairie-Glenrose area. Consideration must be given to the possibility of this future construction.

Method of control applicable to this overflow point would be:

a. Overflow treatment - $230,000

b. Storm sewer separation - $300,000

c. Storage in a covered tank. Pumping would not be required provided the overflow chamber is moved upstream - $150,000

d. Pipe the overflow downstream to the next overflow point - $450,000

It appears that tank storage of overflows provides the most economical solution but considerations of the operation and maintenance problems would make storm sewer separation the more desirable alternative.

2. Rebecca and Upriver Drive, Overflow Point No. 2 (Exhibit VI-1)

This point is located on top of a bank approximately 40 feet high on the north shore of the river. It serves the only combined sewer area contributing to the Regal Street siphon. Space is available on or below the bank for either overflow treatment or storage facilities. Pumping return flow to the interceptor will be required for either of these methods.

Possible methods of control for this point include:

a. Overflow Treatment - $450,000

b. Storm sewer separation - $400,000

c. Storage facility - $400,000

Storage is not desirable at this site, as the rate of return flow would be controlled by the capacity of the Regal Street siphon, and retention times in the tank would become excessive, resulting in septic sewage during prolonged rainy periods. The most desirable alternative appears to be storm sewer separation.

3. Overflow Point Nos. 3, 4, and 5 (Exhibit VI-1)

These points are located on the south shore of the river at Regal, Altamont and Magnolia Streets. The intercept chambers are located at the top of the bluff on the south side of the river, and very little space is available for storage or overflow treatment. Limited space is available between Magnolia and Mission, lying between South Riverton and the river.

Possible methods of control for these three points are limited to:

a. Storm system separation - $700,000

b. Piping the overflows downstream to a site between Magnolia and Mission with overflow treatment there - $700,000

c. Piping the overflows downstream to Mallon and Perry for further conveyance to Front and Erie - $450,000

Storage is not feasible at these locations due to the size of tanks required, the aesthetic considerations of the areas, and lack of available space. The most desirable alternative appears to be intercepting the overflows for conveyance to Front and Erie.

4. Overflow Points Nos. 6 and 7 (Exhibit VI-1)

These points are located at Sharp and Perry, and at DeSmet and the Burlington Northern Railroad on the north bank of the river. They control flow to the DeSmet siphon. Overflow Point No. 6 at Sharp and Perry serves a combined sewer area and overflows periodically while that at DeSmet and the Burlington Northern Railway, Point No. 7, serves an area already having separate storm sewers and does not overflow under normal conditions.

Possible methods of control are:

a. Overflow treatment - $310,000

b. Storage in a surface tank - $300,000

c. Storm sewer separation in the area served by overflow point No. 6 - $450,000

Storage is not desirable at this point, as the return flow would be controlled by the capacity of the DeSmet siphon, and retention times might become excessive. As a portion of the area is already served by storm sewers, complete separation is the advisable solution.

5. Mallon at Perry, Overflow Point No. 8 (Exhibit VI-1)

This overflow point lies below river high-water level and the interceptor connection must be closed during high river flows, thus discharging untreated sewage. Space is not readily available for any facilities at this point, as all available land is presently utilized. The cost of separation in the contributing area would be approximately $1,000,000.

Lack of space and elevation limit further consideration to conveying the overflow downstream to the area of Front and Erie to be treated in combination with overflows at that point. Estimated cost $100,000.

6. Erie Street Complex, Overflow Points 9 through 14, (Exhibit VI-2)

The Erie Street Complex consists of four major outfall lines containing the flow passing six different overflow weirs, in addition to the proposed line importing overflow to the site from Overflow Points 3, 4, 5, and 8.

The overflow chambers at Front and Erie, Nos. 9, 10, and 14, and at Mallon and Perry, No. 8, were constructed below the high water level of the Spokane River. The chambers function in the designed manner at low river stages, but permit river water to enter the interceptor pipeline at high river stages. In order to prevent this reverse flow, sluice gates have been installed on the lines connecting the intercept chambers to the interceptor pipeline. During high river stage, these gates are manually closed, and sewage flow from these three chambers is discharged directly to the river. This condition exists for a period of three to four months annually.

Limited space is available for either overflow treatment or storage. Storage at this location would be above the trunkline elevation and would require pumping into the storage tank with return by gravity. Tank volume required would be approximately 24 million gallons and would cost $4,500,000, including pumping facilities. Cost, pumping and space requirements for storage lessen its desirability.

For overflow treatment, fine screening and chlorination, topographical features at this point require that a pump station be included to lift the effluent during high-river stage periods.

Regardless of the ultimate disposition of the overflow problem at this location, alleviation of the bypassing of raw sewage for several months each year should be given a high priority. An automated system incorporating flow meters and power operated gates as shown on Exhibit XI-1 would alleviate the problem. This Phase I construction is estimated to cost $500,000.

Estimated cost of the 130 mgd overflow treatment facility for Phase II is $3,700,000. A proposed site for the Erie Street Complex improvements is shown on Exhibit XI-2.

7. Central Business District (CBD), Overflow Points 16, 17, 18, 19, 25 and 26, and Latah Creek Vicinity, Overflow Points 27, 28, 29, 30, 31, 32 (Exhibits VI-3, VI-4, and XI-3)

The central business district is experiencing a multitude of problems due to the advanced age and physical deterioration of the collection system. Some localized repair work is essential immediately, in addition to other longer range corrective measures. Trunk sewers within the central business district (CBD) shown on Exhibit XI-3 are generally undersized for the present tributary areas, even for a one year storm. Replacement with adequate size trunk sewers will be extremely costly due to the concentration of vehicular and pedestrian activity and underground utilities. TV inspection of the CBD trunk sewers disclosed both existing and impending structural failures.

Concepts for correction include:

a. Intercept off-site drainage by constructing two new interceptors, at the south and east fringes of the CBD, thus relieving CBD sewers of loads except that actually generated within the area. Exhibit XI-3 shows the location of these interceptors.

   The first interceptor would be constructed in Browne from Sprague to Trent and would intercept flow entering the central business district from the east. This facility would terminate at the main interceptor in Trent Avenue where an overflow structure could be located to pass overflow from this new line to the south riverfront stormwater interceptor for transmission to the Latah Creek and Spokane River vicinity. Estimated cost $250,000.

   The second interceptor would be located along the southern fringe of the central business district at approximately the location of the freeway, beginning at 4th and Browne, and would accomplish interception of storm or total flows entering the central business district from the south. This new interceptor would terminate in the general vicinity of the confluence of Latah Creek and the Spokane River. This sewer would take only storm overflows from the lines intercepted unless a satellite secondary treatment plant were located at Latah Creek in which case the entire flows from south of the freeway would be intercepted. Estimated cost is $1,800,000.

b. Overflows will still occur with reduced volume and frequency at Overflow Point 18 (Lincoln at Trent - estimated four times per year) and Overflow Point 16 (Cedar at Riverside - estimated two times per year) and Overflow Point 25 (Cedar at Main), after the proposed interceptors on Browne Street and at the freeway have been installed. Control can be accomplished by piping the overflows from these points via the south riverfront overflow interceptor as shown on Exhibit XI-3. This interceptor would carry overflows to the vicinity of the confluence of the Spokane River and Latah Creek for overflow treatment by facilities there. The extension of this line easterly along Trent Avenue to also convey overflow from the new Browne Street interceptor and thus protect available capacity in the main interceptor is desirable.

   The estimated cost of this line is:

From Lincoln Street to Latah Creek	$800,000
Extend from Lincoln Street to Browne	700,000
Total	$1,500,000

c. Repair or replace trunk sewers and laterals within the CBD where structural failure has occurred or appears imminent.

   Major items of replacement and repair requiring immediate attention in the CBD are:

   (1) Relay and enlarge the "old downtown" line. Two thousand lineal feet of new 24" diameter sewer line should be installed. The minimum requirement is to replace the line on Sprague Avenue between Wall and Lincoln Streets.

   (2) Repair collapsed lamp holes and pipes.

   (3) The approximate cost for Items 1 and 2 above is $500,000.

   (4) A listing of other defects revealed by the TV inspection is on file with the city. Correction of these defects should be included in normal maintenance work and no capital cost for this work is included in this report.

d. The costs for total separation were estimated. The actual cost of installing such a system is far beyond the cost of installing the pipe itself. These include possible damages involved in the relocation of a multitude of existing underground utilities as well as traffic disruption and disruption of the business community as a whole. Cost is estimated to be between $7,000,000 and $10,000,000.

e. The stormwater overflow treatment facility required for the Latah Creek site, regardless of whether the biological treatment facility is placed there, would be for a 100 mgd five-year storm flow and would cost an estimated $2.9 million, assuming the freeway interceptor is constructed. If both the freeway and south riverfront storm water interceptors are installed, this overflow treatment facility would be for 170 mgd five-year storm flow and cost approximately $4.6 million. Exhibit XI-4 shows a proposed site for overflow facilities. Careful attention to final site selection and design detail will be necessary to assure that the proposed facility blends harmoniously with the proposed park improvements in the area.

Overflow Point No. 19 serves Havermale Island. Sanitary sewers included in Expo 74 construction should exclude storm runoff. No further improvements will be necessary. Overflow Point No. 26 is the protective overflow for the wet well in the Elm Street pumping station. It will not operate under normal conditions.

Overflow Points 27, 28, 30, and 31 are located near the present point of confluence of the sewer lines serving the southwest area of the city and Spokane International Airport. Overflow Point No. 29 is located near the east end of the freeway bridge across Latah Creek. Overflows from these points will be conveyed to the treatment facilities provided for overflows intercepted from the CBD.

Overflow Point No. 32 is the protective overflow for the wet well in the Clarke Street pumping station. It will not operate under normal conditions, as standby pumping facilities are installed in the lift station.

8. The "North Bowl" Area, Overflow Points 20, 21 and 22 (Exhibit VI-4)

The trunkline for the North Bowl Area is shown on Exhibit XI-5. Flows are collected from as far east as Hamilton Street, from as far west as Ash Street, and from as far north as Buckeye, with the three major lines merging at Stevens and Indiana. All three lines are surcharged above this point during storms and some relief is required. The line downstream from this point lacks the capacity to convey these combined flows and severe flooding conditions occur even with a very light rainfall.

An in-system overflow, Point No. 20, occurs at Astor between Boone and DeSmet, and is created by insufficient downstream capacity of the main.

At the downstream end of the trunkline in Division, near the river, a 42 inch interceptor receives the flow and conveys it westerly approximately parallel to the river. At Washington, the line reduces to 27 inches, with an associated overflow, Point No. 21. At Howard, the line reduces to 24 inches, to enter the siphon leading to the main interceptor. The Howard Street line also enters the siphon at this point, and another overflow, Point No. 22, occurs here.

Methods of control and combinations of them are:

a. Install a new line from Overflow Point 20 to Division Street - $75,000.

b. Install three upstream overflow collectors on three lines leading to Stevens and Indiana - $200,000.

c. Three alternatives exist for carrying flow away from Stevens and Indiana:

(1) Install a pumping chamber in the vicinity of Stevens and Indiana to pump the excess flow to a high point at Spofford and Howard. A new gravity line would convey the flow from this point west on Spofford to combine with the overflow at Nora and Pettet Drive. Estimated cost not including treatment, $1,700,000.

(2) Install an overflow interceptor line parallel to the existing line from Stevens and Indiana to Division and Cataldo - $675,000.

(3) Install an overflow interceptor line from Stevens and Indiana south on Washington to Cataldo. Requires a tunnel section under the hill - $1,275,000.

d. Two concepts for alleviating the overflows from Points 21 and 22 are:

(1) Replace the 27 inch line from Washington to Howard with a 42 inch line. At Howard, combine this with the existing line on Howard, provide overflow treatment for the overflow and discharge to the river. Screenings and dry weather flow would enter the siphon, which in turn joins the intercepter at Lincoln and Bridge. Estimated cost of the 70 mgd facility is $2,100,000.

(2) Install a new gravity overflow interceptor line from Division and Cataldo to Mallon and Howard, west on Mallon to Post, south on Post to Broadway, west on Broadway to Lincoln, south on Lincoln to Bridge, and west on Bridge to join the pipeline recommended to convey overflows from Monroe to Cedar and Ide for overflow treatment there. Overflows would be intercepted at Washington and Howard by this line. The existing lines would be left intact to convey dry weather flow.

Estimated cost of this interceptor line is $850,000. This proposal would physically remove the overflow from the Expo 74 area and concentrate the storm overflows from the area between Division and Cedar at one point. This would be advantageous if urban storm runoff is required to be treated more completely in the future.

e. Cost of total separation of the entire drainage basin is estimated at $4,000,000. Recommended facilities are shown on Exhibit XI-5.

9. Monroe at Bridge Street, Overflow Point 23 (Exhibit VI-4)

The line on Monroe Street drains a highly developed commercial and industrial area. Storm flows are many times the dry weather flow, and the present overflow discharge is located immediately upstream of the Monroe Street Bridge in one of the more scenic portions of the river.

Space is not available in which to accomplish treatment or storage.

A line installed in the parking area next to Ide Street, as shown on Exhibit XI-5, would convey the overflow from Monroe Street westerly to Cedar Street.

Here the flow would be combined with the overflow at Cedar and Ide for treatment. Estimated cost of this interceptor is $150,000.

Cost of separate storm sewers for this area is estimated to be $1,000,000.

10. Cedar and Ide, Overflow Point 24 (Exhibit VI-4)

The trunkline coming into Cedar and Ide is severely overloaded in the downstream portions. The overflow at Cedar and Ide would be combined with that imported from Monroe and Bridge for overflow treatment at this point. A proposed site location for this facility is shown on Exhibit XI-6. Estimated cost of the 40 mgd facility is $1,400,000.

If flow is included from the Indiana at Stevens to Division Street overflow interceptor and from Division, Washington and Howard Streets, the estimated overflow treatment facility cost for 110 mgd is $3,200,000.

Limited space is available for treatment facilities in the area; storage at this site appears to be neither economically or aesthetically justifiable. Cost of separation for the Cedar and Ide contributing area is estimated at $2,000,000.

11. Sherwood and Summit, and Nettleton and Ohio, Overflow Points 33 and 34 (Exhibit VI-4)

Overflow Point 33 serves the residential area on the bluff overlooking the old Natatorium Park area. The 12 inch interceptor line conveying the intercepted flow from this area to Overflow Point 34 at Nettleton and Ohio cannot carry the storm flows generated. Space for treatment facilities is not available at the overflow site. Space is available at the foot of the bluff at the extreme upstream end of the old Natatorium Park river bottom. Alternate solutions at this site are:

a. Lay a parallel interceptor pipe to convey the overflow to Overflow Point 34 for overflow treatment at that location. Approximately 4,500 lineal feet of pipe would be required. Estimated cost $500,000.

b. Storage at the foot of the bluff for later return to the interceptor. The pumping head of approximately 150 feet makes this method impractical.

c. Install an overflow treatment plant at the foot of the bluff, extend the existing sanitary sewer line further up Evergreen Street into the presently unsewered area to receive the screenings from the proposed plant and convey them to the present San Souci West pumping station. In order to avoid recycling the screenings past the same overflow weir, it would be advisable to extend the force main discharge point one block further east to the line at Sinto and Lindeke, which drains easterly to Pettet Drive and Nora Street. Estimated cost for this alternate is $250,000.

At Overflow Point 34, space is available for any type facility, but pumping would be required for storage. Moving the overflow chamber further upstream to gain elevation would permit the installation of overflow treatment without pumping.

Alternate solutions here include storage, estimated cost $250,000, or overflow treatment, estimated cost $450,000.

The estimated cost of total storm sewer separation for the two areas is $1,300,000.

It appears that overflow treatment and/or storage offers the least expensive solution. However, consideration of operation and maintenance problems make separation a more desirable alternative.

12. Nora and Pettet Drive, Overflow Point 35 (Exhibit VI-4)

This overflow point is located at the brow of the hill at the point where Pettet Drive begins its descent to become the river bottom scenic view drive. Very limited space is available. Additionally, this area is park property, and as such is subject to future development.

Alternate solutions for control consist of:

a. Overflow treatment - $750,000

b. Tank storage for later return to the interceptor - $550,000

c. Pipe downstream to Cochran and Grace - $500,000

d. Storm sewer separation - $2,000,000

The quantities involved and the size storage tank required makes storage aesthetically undesirable at this point.

The most desirable alternate is to pipe the overflow downstream to combine it with the flow at T. J. Meenach Drive.

13. T. J. Meenach Drive Facilities, Overflow Points 36 and 37 (Exhibit VI-5)

Overflow Point 36 is on the large trunk sewer serving the northeast section of the city. Intercepted flow is conveyed to the main interceptor by means of a 21 inch siphon. Overflow Point 37 at Cochran and Buckeye is on an 18 inch sewer main serving a local area lying west of Northwest Boulevard and south of T. J. Meenach Drive. Intercepted flow is conveyed through an 8 inch sewer connected to the 21 inch siphon from Overflow Point 36. The 21 inch siphon has barely the capacity to convey the peak dry weather flow from these lines.

Alternate solutions for these points include:

a. Storage of the combined overflows in a tank which would require siting below the elevation of the main interceptor, with associated return pumping. This facility has an estimated cost of $4,500,000.

b. Extension of the 90 inch trunk line northwesterly from Point 36 around the brow of the hill, installation of a new overflow weir there and an overflow treatment facility adjacent to the T. J. Meenach Drive and Aubrey L. White

Parkway intersection. All dry weather flow and screenings would go to the interceptor. The overflow from Points 37 and 35 would be rerouted to this overflow treatment facility. The cost for this 120 mgd overflow treatment and piping alternate is estimated to be $3,400,000.

c. Storm separation for area tributary to Overflow Point 37, Cochran and Buckeye - $500,000.

Exhibit XI-7 shows improvements for the T. J. Meenach Drive area. Careful attention to final site selection and design detail will be necessary to assure that the proposed facility blends harmoniously with the proposed park improvements in the area.

14. Columbia Circle, Northwest Boulevard and Kiernan, Overflow Points 38 and 39 (Exhibit VI-6)

Overflow Point No. 38 is located near the Downriver Golf Course in a well developed and popular recreational area. Space is available for either storage or treatment within a reasonable distance from the overflow point, but construction costs to maintain aesthetic values in the area would be excessive. The estimated cost for storm sewer separation is $650,000.

An alternate is to intercept the overflow from Point 38 and Point 39 and convey them to the main sewage treatment plant site. Estimated cost is $200,000, including $70,000 for the interceptor from Overflow Point 38 to 39. The estimated cost for storm sewer separation for the area contributing to Point No. 39 is $3,000,000.

15. Hollywood Interceptor Complex at Northwest Boulevard and Assembly, Overflow Points 40, 41, 42, 43, and 44 (Exhibit VI-7)

Two 36 inch lines convey flows from the extremities of the trunk zone to the area of Assembly and Queen, which is drained by a single 36 inch line. Considerable ponding and basement flooding has been encountered in this area.

An interceptor line is needed on Assembly to be connected to the existing 42 inch stub in the overflow chamber there.

Overflows can be mitigated by a line installed at the foot of the hill to convey the total overflow from Hartley Street (Point No. 42) southerly along Aubrey L. White Parkway, intercept the combined overflows from the Hollywood trunk interceptor (Points 40, 41, 43 and 44) and join the overflow interceptor from Points 38 and 39. Estimated cost $150,000.

Flow from these overflow interceptors would receive overflow treatment by a facility installed at the main treatment plant. Transport facilities for the Hollywood Interceptor complex are shown on Exhibit XI-8.

The estimated cost for separation is $6,000,000.

16. High Drive near 33rd, Overflow Point No. 15

Overflow Point No. 15 discharges to a holding pond near Latah Creek, which normally contains the overflows.

17. Storm Relief for the Northeast Sector.

Two concepts have been advanced to relieve the surface ponding in the area east of Division between Wellesley and Francis, and to reduce the quantity of storm flow presently overloading the combined subtrunks in Regal, Crestline, Perry, Nevada, and Addison. Either of these concepts would also reduce the quantity of storm flows reaching Overflow Point 36 by about 20 percent.

(1) Install a dry well at each intersection to receive excess flow from the catch basins and allow it to percolate into the soil. If this is connected to the catch basin with a siphon type arrangement, the greater portion of the suspended solids would be prevented from entering the dry well. Estimated cost $450,000.

(2) Install a separate storm line in Regal from a discharge point at the river upstream to Francis, with submains extending west on Wellesley and Rowan to Division as shown on Exhibit XI-9. Plug or remove the existing catch basins, and install gutter crosspans at intersections to convey the storm flow on the surface to a series of new inlets along the route of the new storm line. Estimated cost $3,000,000.

18. Overflow Treatment O & M

Operation and maintenance costs for the overflow treatment facilities are difficult to determine due to lack of experience with such installations. Estimated O & M costs for the North Bowl and T. J. Meenach Drive facilities will be about $50,000 annually and for the Erie Street and Latah Creek facilities about $70,000 annually. These figures could be increased substantially if high recurring costs for such items as screen replacement are experienced.

E. COST SUMMARY FOR INDIVIDUAL AREAS

The cost of various alternative correction facilities at the individual areas is as follows. The alternative appearing to be the most preferable at each location is designated by an asterick (*).

Surro & South Riverton (Overflow Point No. 1)

1.	Overflow treatment	$230,000
2.	Storm sewer separation	300,000*
3.	Storage	150,000
4.	Pipe downstream	450,000

Rebecca & Upriver Drive (Overflow Point No. 2)

1.	Overflow treatment	$450,000
2.	Storm sewer separation	400,000*

3. Storage 400,000

Overflow Points No. 3, 4, and 5 (Regal, Altamont & Magnolia at Upriver Drive)

1. Storm sewer separation $700,000
2. Pipe to Magnolia & Mission with overflow treatment 700,000
3. Pipe to Mallon & Perry for further conveyance 450,000*

Overflow Points No. 6 and 7 (Sharp at Perry and DeSmet at B.N. Ry.)

1. Overflow treatment $310,000
2. Storage 300,000
3. Storm sewer separation 450,000*

Mallon at Perry (Overflow Point No. 8)

1. Storm sewer separation $1,000,000
2. Pipe downstream to Front & Erie 100,000*

Erie Street Complex (Overflow Points 9 through 14)

1. Storage $4,500,000
2. Phase I - Bypass elimination 500,000*
   Phase II- Overflow treatment 3,700,000*

Central Business District (CBD) and Latah Creek (Overflow Points No. 16, 17, 18, and 25 through 32)

1. Browne Street Interceptor $250,000*
2. Freeway interceptor 1,800,000*
3. South riverfront storm water overflow interceptor 1,500,000*
4. Required repair & replacement 500,000*
5. Storm sewer separation 7 to 10,000,000
6. Overflow treatment at Latah Creek 4,600,000*

North Bowl Area (Overflow Points No. 20, 21 & 22)

1. New line downstream from Pt. 20 75,000*
2. Upstream overflow collectors above Stevens & Indiana 200,000*
3. Pumping station at Stevens & Indiana with force & gravity line to Nora & Pettet Drive 1,700,000
4. Overflow interceptor line from Stevens & Indiana to Division & Cataldo 765,000*
5. Overflow line on Washington from Stevens & Indiana to Cataldo (tunnel sections) 1,275,000
6. Replace 27 inch section of existing interceptor and install overflow treatment at Howard 2,100,000
7. Overflow interceptor from Division to Monroe 850,000*
8. Storm sewer separation 4,000,000

Monroe at Bridge (Overflow Point No. 23)

1. Pipe to Cedar & Ide $150,000*

Cedar & Ide (Overflow Point No. 24)

1. Overflow treatment
   a. This area & Monroe Street 1,400,000
   b. All areas Division to Cedar 3,200,000*
2. Storm sewer separation (this area only) 2,000,000

Sherwood & Summit (No. 33) & Nettleton & Ohio (No. 34)

1. Overflow Point No. 33
   a. Parallel interceptor pipe (33 to 34) $500,000
   b. Storage not practical
   c. Overflow treatment 250,000

2.	Overflow Point No. 34		
	a.	Storage	250,000
	b.	Overflow treatment	450,000
3.	Storm sewer separation (both areas)		1,300,000*

Nora & Pettet Drive (Overflow Point No. 35)

1.	Overflow treatment	$750,000
2.	Storage	400,000
3.	Pipe to Cochran & Grace	500,000*
4.	Storm sewer separation	2,000,000

T. J. Meenach Drive (Overflow Points 36 and 37)

1.	Storage	$4,500,000
2.	Extend line with overflow treatment	3,400,000*
3.	Storm sewer separation (Overflow Point No. 37 only)	500,000

Columbia Circle (No. 38) and NW Blvd. at Kiernan (No. 39)

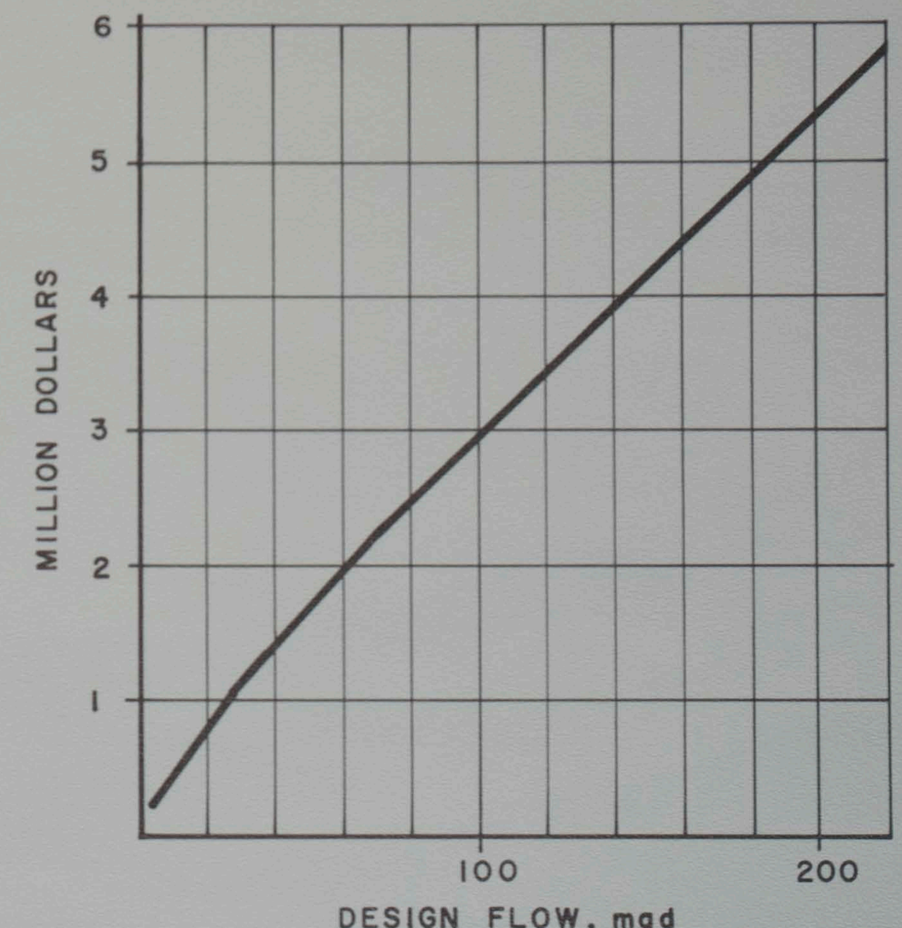
1.	Overflow Point No. 38		
	a.	Storm sewer separation	650,000
	b.	Pipe to Point 39	70,000*
2.	Overflow Point No. 39		
	a.	Storm sewer separation	3,000,000
	b.	Pipe to treatment plant	130,000*

Hollywood Interceptor Complex at NW Blvd. & Assembly (Overflow Points No. 40 through 44)

1.	Overflow interceptor	$150,000*
2.	Storm sewer separation	6,000,000

Overflow Treatment Facilities
O & M Costs--Annual

Erie Street Complex	$ 70,000
Latah Creek	70,000
North Bowl - Cedar and Ide	50,000
T. J. Meenach Drive	50,000



COST OF SCREENING-DISINFECTION FACILITIES

FIGURE XI-I

The existing primary treatment facilities are described in Chapter VI. Exhibit VI-8 shows the existing plant layout and flow schematic. Plant performance is discussed in Chapter VI, and graphically presented on Exhibits VI-9 through VI-11.

Directives from the State of Washington to the City of Spokane state that dry weather sewage flows shall receive secondary treatment and improved disinfection [12-1]. A time schedule has been established for its accomplishment. Present Federal guidelines for administration of Public Law 660 sewage treatment plant construction grants are such that grants are not made available to municipalities unless upgrading plans include at least secondary treatment facilities when the discharge is to any waters other than those of the open ocean.

The State of Washington has defined secondary treatment as "the removal of settleable and floatable solids from the waste flow and the application of additional waste treatment processes to attain a minimum of 85 percent removal of BOD and 90 percent removal of suspended solids, followed by adequate disinfection of the effluent [12-1]. They indicate adequate disinfection has been obtained when "the treated effluent exhibits a median value of total coliform organisms of 2,400/100 ml or less with no more than 10 percent of the samples exceeding 10,000/100 ml."

In the light of State directives and the problems now inherent in the Spokane River (Chapter V), a priority goal of secondary treatment for Spokane's dry weather sanitary sewage discharge should be established. Downstream benefits could be realized following reduction of the BOD and suspended solids load from Spokane. Although existing disinfection practices are very nearly adequate as defined by the State, it would be desirable to set a goal of 1,000 coliforms/100 ml or less in the treatment plant effluent, for added protection to downstream water uses.

Legislation presently before Congress has a stated policy that "the discharge of pollutants into the navigable waters be eliminated by 1985." As the Spokane River is a "navigable water," it will be subject to the provisions of this legislation. Constituents of discharges which are to be considered pollutants are not defined in the legislation. If total elimination of Spokane's sewage discharge were legislated, secondary treatment would be prerequisite to presently considered reclamation and reuse concepts. If removal of phosphorus, nitrogen or other constituents became necessary to meet these legislated requirements or objectives prescribed by a future regional water quality plan, secondary treatment would be compatible with processes for its achievement according to best present knowledge of the technology.

A. TREATMENT PLANT SITING

1. Existing Plant Site

The existing sewage treatment facilities are located adjacent to the Spokane River in the northwest portion of the city. The River at this point flows through a canyon with relatively steep banks separating it from residences in northwest Spokane. The treatment plant is situated on a site between a high bank and the river with State Park land both up and downstream. The property directly across the river is also State Park land.

The existing site is nearly fully occupied by the present treatment plant and the location of secondary treatment facilities will be difficult. This means that new facilities possibly must be located on property which is presently within the State Park.

A bench of land at a slightly lower elevation than the sewage treatment plant is located upstream and expansion in this direction would be possible. The land is within the Riverside State Park, and additionally is within the Stoolfire hydroelectric flood easement. Although the power development is unlikely to be realized, construction within that area would necessarily be preceded by negotiation for the relinquishment of the flood easement or raise the possibility of future dike works to protect the improvements. Negotiation with State officials would be necessary prior to construction within the Park boundary.

The Riverside State Park property directly across the river from the existing treatment plant site may be suitable for location of expanded treatment facilities. The elevation of this large bench area is approximately the same or slightly higher than that of the existing site. It would be necessary to provide access to the facilities via a bridge from the existing treatment plant site. The facilities must blend into the Park surroundings.

2. Additional Treatment Sites

Consideration has been given to the establishment of sanitary sewage treatment facilities remote from the existing location, satellite plants, serving specific collection areas within and adjacent to the city. One such facility is proposed for location at roughly the confluence of Latah Creek and the Spokane River. It would serve the South Hill area, Spokane International Airport, areas east and west of Latah Creek and an area now largely undeveloped between the existing city and the airport area. The purpose of this facility would be to relieve the interceptor system and the treatment facilities at the existing site. The plant would return concentrates to the interceptor system, thereby keeping the sludge handling and disposal facilities at one location, the existing plant site.

A future treatment plant in the vicinity of Felts Field could treat flows from east and southeast of the presently sewered area.

B. SEWAGE TREATMENT PLANT DESIGN LOADINGS

Projections from operating records at the existing sewage treatment plant and from population records were used to predict future sewage treatment plant loadings. A linear regression line utilizing the twelve year annual average daily flow, Exhibit VI-9, indicated future flows somewhat higher than those obtained using population predictions presented in Chapter IV. Based on the 1970-1971 average flow and 1970 census population, 164 gallons per capita per day is the unit flow contribution. Flow predictions utilizing the two methods are shown in Table XII-A.

TABLE XII-A
FLOW PREDICTIONS--SPOKANE SANITARY SEWAGE

Year	Predicted Average Daily Flow Based on Past Flow Records	Population Predictions
1990	40.6 mgd	30.1 mgd
2000	47.2 mgd	30.6 mgd

The predictions based on flow records may be high, as trunk sewers serving some areas of the city were connected to the interceptor during the record period. The predictions based on per capita flow may be low as domestic water usage and commercial and industrial use are increasing on a per capita basis. The design annual average daily flow must be established somewhere between the extremes shown in Table XII-A. A design average daily sewage flow of 35 mgd will serve Spokane's needs through 1990 and probably through 2000.

Table XII-B contains existing and proposed treatment plant design loadings. These loadings were obtained from sewage strengths reported in Chapter VI and the existing and projected flows. No sewage strength changes are anticipated except as transient changes when stormwater treatment residuals are returned to the interceptor.

TABLE XII-B

DESIGN CRITERIA - PROPOSED SECONDARY TREATMENT PLANT

Sanitary Sewage Flow	1970-1971 AVERAGE	PROPOSED DESIGN
Annual Average		
Daily mgd	28	35
Daily maximum	39	49
Maximum Month		
Average daily mgd	33.5	42
Daily peak mgd	47	59
Secondary Treatment Capacity, mgd		60
BOD, Annual average #/day	33,300 (0.196/cap)	41,600
Suspended Solids, annual average #/day	29,300 (0.172/cap)	36,600
Sludge Production, annual average #D.S./day	32,100	65,600
Sludge Production, annual average #D.V.S./day	23,100	47,300

C. SECONDARY TREATMENT FACILITIES

Several alternative methods for providing treatment and disinfection for flows conveyed to Spokane's sewage treatment plant have been considered and are discussed in this section. Cost estimates for the various facilities were obtained from curves prepared by the consortium of consultants for the San Francisco Bay - Delta Water Quality Control Program. These costs were increased by 30 percent to reflect 1972 cost levels.

Overflows occur from trunk sewer lines ahead of their confluence with the wastewater interceptor. As proposed facilities for treating these stormwater overflows would return concentrates to the interceptor line, the flows entering the sewage treatment plant will contain a higher concentration of pollutants than upstream stormwater overflows. Therefore, it would be desirable to provide a higher degree of treatment to the overflow at the main treatment plant than at the individual points of overflow within the system.

In order to provide at least preaeration and primary treatment to all flows conveyed to the treatment plant in the main interceptor, a primary treatment capacity of 110 mgd would be required. However, if provision were made for splitting the waste flow following screening and grit removal, 50 mgd to the existing primary treatment facilities and up to 60 mgd directly to new secondary treatment facilities the objective would be accomplished. During normal operation sanitary sewage would receive primary and secondary treatment. During storm flows the splitting device would be actuated so a portion of the flow would receive primary treatment only.

The design flows and other loading criteria at existing and design conditions are tabulated in Table XII-B. This table and discussions in Section B of Chapter VI indicate that: secondary treatment facilities are needed; and screening and grit separation, sludge handling facilities, and disinfection facilities need expansion.

1. Physical Chemical Treatment

A physical chemical secondary treatment process would consist of chemical precipitation using lime, followed by a sorption process, probably using activated carbon in granular or powdered form, followed in turn by a solids removal step such as rapid sand or mixed media filtration. About 90 percent phosphorus removal would be accomplished. This facility, based on a design average flow of 35 mgd, would have an initial capital cost of nearly $18 million if constructed at the existing plant site. The cost would increase by about $2 million if facilities were moved across the river. These facilities and the required chemicals would impose an operation and maintenance cost of about $1.6 million per year.

The installation of the chemical precipitation treatment step following the existing primary plant would allow probable reduction in chemical costs and improved performance during normal operation. It would also allow chemical precipitation of 60 mgd and primary treatment of an added 50 mgd during storms by operating the new facilities and the existing primary plant in parallel. Sorption flow would be restricted to the design flow. Hollywood Area overflows of 105 mgd (five year flow) could be treated by a $3.0 million screening-chlorination facility at the treatment plant site. The O & M costs for this overflow treatment facility are estimated at $50,000 annually.

2. Biological Treatment

Biological treatment would consist of the activated sludge process. Its cost, based on a 35 mgd design average flow, is estimated to be $8 million, if located on the same side of the river as the existing primary facilities. Additional plant site area will probably be required. Access to a location on the opposite river bank would increase the costs by about $2 million. The operating and maintenance costs would be about $520,000 annually. The design and construction would allow the activated sludge plant to treat peak flows up to 60 mgd and split the influent during storm periods, so primary treatment could be given to an additional 50 mgd of stormwater. An additional 105 mgd screening and chlorination plant (approximately $3.0 million) could provide treatment for storm overflows from the area served by the Hollywood Interceptor (Zone X). The O & M costs for this overflow treatment facility are estimated at $50,000 annually.

Exhibit XII-1 shows a layout for locating secondary treatment facilities on an expanded site on the existing plant side of the river. Exhibit XII-2 shows a layout for locating the secondary facilities on the opposite side of the river. Sludge handling, pretreatment, and primary treatment, and overflow treatment facilities would remain on the existing plant side of the river.

3. Alternative Biological Treatment Processes

Biological treatment process variations other than conventional activated sludge may offer cost savings and warrant consideration. Cost curves used in this study are not necessarily applicable for the individual process variations. They were utilized to maintain a consistent basis for comparisons.

a. Contact Stabilization

In contact stabilization the return sludge-sewage mixture is given a relatively short aeration time prior to settling, and the return sludge is reaerated in basins with a somewhat longer detention time. The total aeration tank volume may be reduced by up to 30 percent for this process as the mixed liquor solids are retained at a higher concentration, thus allowing retention of the same total amount in a smaller volume. Operating costs would not be reduced and land requirements would probably still entail obtaining additional area. Consideration should be made of this process in preliminary design phases to further assess its feasibility.

b. Enriched Oxygen Activated Sludge

The enriched oxygen activated sludge process utilizes a gas stream composed of 95 percent oxygen instead of air. Aeration basin volume requirements may be reduced by 30 percent or more but construction costs are not decreased in a like amount, as a gas tight cover must be placed on the basins. The oxygen production facility would be an added capital cost item likely offsetting the aeration basin cost savings. Operation and maintenance costs would be approximately equal to those of a conventional activated sludge facility. This process should be further considered in the preliminary design phase of the sewage treatment plant upgrading project, and is further discussed in the following section.

c. Elimination of Primary Clarification

Within any of the biological processes discussed, activated sludge, contact stabilization, or enriched oxygen activated sludge, the possibility is present for passing the sewage directly to the aeration basins following screening or comminution and grit removal. This would free the existing primary clarifiers for use as secondary clarifiers and thus reduce the capital costs associated with secondary treatment. By using the enriched oxygen process or contact stabilization, there appears to be sufficient area available on the present site to accommodate the aeration basins as shown on Exhibit XII-3. Further expansion would be impossible without land acquisition. Considerations detrimental to this approach are: 1) the increased air supply requirements to accommodate the BOD load which would otherwise be removed in primary settling; 2) the increased difficulty of handling, dewatering and disposing of a strictly biological sludge, as opposed to part primary and part biological sludge; 3) the removal of the option for primary treatment of up to 50 mgd of storm water in parallel to secondary treatment of unsettled flows; and 4) peak flow for the secondary facility could be no more than 50 mgd and possibly less, depending on the secondary clarifier overflow rates required for consistent operation. The imposition of 50 mgd on the existing clarifier area means the overflow rate would be 1,000 gal/s.f./day, probably high enough to result in some solids carry-over.

The cost savings for a 35 mgd average flow, 50 mgd peak flow plant would be about $1.5 million by employing this process, thereby reducing the estimated cost from $8 million to $6.5 million. Thus it would appear that a substantial saving could be realized by employing enriched oxygen activated sludge or contact stabilization and converting the existing clarifiers to secondary units. No reduction in sludge handling requirements or O & M costs are visualized. Offsetting this saving would be an increase in overflow treatment facility size from 105 to 165 mgd and an estimated cost increase from $3.0 million to $4.5 million. Overflow treatment facility O & M costs would increase from $50,000 to $70,000 annually. The existing site may not provide sufficient space for the construction of overflow treatment facilities.

4. Nutrient Removal

a. Phosphorus

The installation of a tertiary chemical precipitation process following biological treatment could achieve phosphorus removal to about 1 mg/l under normal operating conditions, but would require about $3.3 million in construction costs. Operation and maintenance costs would be about $500,000 annually. Phosphorus removal in conjunction with activated sludge processes where metal salts are added in or following aeration has been proposed in other areas [12-2]. An additional phosphorus removal process is available where lime addition to the primary clarifier influent precipitates phosphorus for removal with primary sludge [12-3].

Provision for the possibility of future addition of phosphorus removal facilities should be included in treatment plant planning. Secondary treatment site plans on Exhibits XII-1 and XII-2 show locations for future tertiary phosphorus removal facilities. Tertiary phosphorus removal facilities would be impossible to locate on the existing site.

b. Nitrogen

The only facility presently in operation in the U. S. that approaches full-scale nitrogen removal is at South Lake Tahoe Public Utility District where air stripping a portion of the high - pH chemical precipitation effluent removes ammonia [12-4]. The process is not suited to cold climates, as exists in Spokane. Ion exchange techniques are available but are expensive at about 8 cents per thousand gallons [12-5]. Nitrogen removal appears to be possible by nitrification-dentrification in a three stage biological system [12-6]. Construction cost for the three stage system would be about double the cost for conventional secondary treatment. Should nitrogen removal become necessary to comply with Federal legislation or with future river basin water quality plans, pilot studies and evaluation of latest techniques would be necessary.

D. MULTIPLE TREATMENT SITES

The installation of a dry weather flow treatment facility at the confluence of Latah Creek and the Spokane River has been proposed. It would initially be designed to handle 10 mgd of average dry weather flow. This facility would cost approximately $3.1 million and have an operating and maintenance cost of about $210,000 annually.

Specifically, this plant would treat dry weather flows presently being lifted across the river and into the interceptor leading to the sewage treatment plant by the Clarke Street pumping station and those collected in the proposed interceptor sewer along the route of the interstate freeway.

The main treatment plant design at the existing site could then be reduced to 25 mgd design average flow with a peak flow of 50 mgd. This facility is estimated to cost about $6.3 million for 25 mgd design average flow and have an annual O & M cost of $400,000.

A 115 mgd overflow treatment plant would be required if peak flow splitting to primary and secondary units were possible and would cost $3.3 million. Its annual O & M costs are estimated at $50,000 per year.

The two secondary treatment facilities would have a combined estimated capital cost of $9.4 million and annual O & M of $610,000 as opposed to $8.0 million and $520,000 annually for a single 35 mgd plant.

An advantage of constructing the additional plant would be the increased possibility for placement of the main facility within the existing site, especially if the enriched oxygen activated sludge treatment were used and primary clarification eliminated. Overflow treatment facilities would possibly not fit on the site. The cost of the 25 mgd design average treatment facility would be decreased by about $1.0 million if the existing clarifiers were used for secondary settling. However, the possibility for splitting storm flows to the primary and secondary treatment facilities would be removed and the saving would likely be offset by the increased cost of the overflow treatment facility. A 165 mgd overflow treatment plant is estimated at $4.5 million, with an estimated O & M of $70,000 annually.

If tertiary phosphorus removal facilities were required they would incur future capital costs of $3.9 million as opposed to $3.3 million for a single 35 mgd plant.

Operating and maintenance costs for the two phosphorus removal plants would be about $540,000 per year as opposed to $500,000 for the single facility.

E. SUMMARY

This chapter has presented a discussion of alternative means for compliance with State requirements for secondary treatment of dry weather sewage flows from Spokane. In comparing the alternatives available, future needs and storm flows have been considered. The estimated 1972 costs, capital and O & M, for the various alternatives for upgrading the treatment facilities are presented in Table XII-C. These cost estimates are the result of comparisons with facilities of similar size and complexity. No preliminary designs were prepared for obtaining estimates.

An analysis of the alternatives and their costs yields the following observations:

1. Biological treatment facilities present a more economical alternative than physical-chemical treatment, both from a capital cost and annual O & M standpoint. Of the biological processes considered, insignificant total cost differences exist.

2. A single facility rather than plants at the existing site and at a satellite location would result in lower costs, both capital and O & M. The cost differential would increase if tertiary treatment were required.

3. Secondary facilities possibly cannot be located on the existing plant site, and additional site area may be needed. The installation of secondary facilities would be feasible on the existing plant side of the river but would require use of the major portion of the level benchland upstream of the present plant site. It will also entail acquisition of park land and relinquishment of the flood easement held on the lower elevation property considered.

   Exhibit XII-1 shows a layout for biological secondary facilities on the existing plant site side of the river. Area for an overflow treatment facility for the Hollywood Interceptor area overflows is included as is area for a possible future tertiary phosphorus removal process.

   Exhibit XII-2 shows a layout for secondary treatment facilities on the opposite side of the river from the existing treatment plant site. Stormwater treatment and sludge handling facilities would remain on the existing side. This site would entail obtaining state park property and construction of an access bridge. It would allow more accessible area for future facilities and permit greater flexibility in developing an aesthetically pleasing facility.

   Exhibit XII-3 shows a layout for secondary facilities confined to approximately the existing treatment plant site. The overflow treatment facilities may require additional area and future expansion or the addition of tertiary treatment would require land acquisition.

4. Provision for addition of tertiary treatment facilities should be included in secondary treatment plant planning.

5. Detailed cost estimates for various treatment alternatives should be developed from preliminary designs and current unit construction and equipment costs.

6. The design of a biological treatment facility could be refined considerably leading to better economy of facilities if pilot studies were performed.

TABLE XII-C

PRELIMINARY COST ESTIMATES FOR UPGRADING SEWAGE TREATMENT FACILITIES

	Capital Cost ($ Millions)			Annual
	Treatment[1] Facility	Overflow[2] Treatment	Total	O & M[3] ($Thousand)
Physical-Chemical Treatment	18.0	3.0	21.0	1,600
Biological Treatment Conventional Activated Sludge[4]	8.0	3.0	11.0	520
Enriched Oxygen Activated Sludge[5]	6.5	4.5	11.0	520
Phosphorus Removal - Tertiary (Possible Future)	3.3			500
Activated Sludge Treatment - 2 Sites[4]				
Existing Site	6.3	3.3	9.6	400
Satellite	3.1		3.1	210
Total	9.4	3.3	12.7	610
Enriched Oxygen - 2 Sites[5]				
Existing Site	5.3	4.5	9.8	400
Satellite Plant	3.1		3.1	210
Total	8.4	4.5	12.9	610
Access to Plant Across Spokane River[6] (Optional)	2.0		2.0	

1. Secondary treatment facilities for 35 mgd design average flow.

2. Facilities for fine screening and chlorination at existing site in excess of the capacity of primary and secondary facilities in parallel.

3. In addition to present O & M costs. Does not include overflow treatment facilities.

4. Also applies to contact stabilization and enriched oxygen activated sludge except as noted in 5.

5. Utilizing existing primary clarifiers as secondary clarifiers and eliminating primary treatment.

6. Applicable to all alternatives for installation of plant improvements on the opposite side of the river from the existing plant site.

XIII. THE RECOMMENDED SYSTEM AND ITS IMPLEMENTATION

The preceding chapters developed alternatives by which the City of Spokane may participate in abating pollution in the Spokane River. This chapter presents the recommended plan and cost summary. Three levels of construction priority are presented, and financing and revenue considerations are discussed.

A. BUDGETARY COST ESTIMATES

The following alternatives were compared:

1. A secondary sanitary sewage treatment facility plus storm sewer separation. Cost is estimated to be in excess of $100 million.

2. Increased interceptor capacity and a secondary treatment facility to treat sanitary plus storm flows. Estimated cost is $60 million to $70 million.

3. A secondary sanitary sewage treatment facility plus overflow treatment facilities at five locations and sewer separation in some areas. Estimated cost is $35 million to $40 million.

Alternative No. 3 is recommended, and these facilities are shown on Exhibit XIII-1. The equivalent of primary treatment of overflows will be provided. Overflow treatment facilities as proposed for combined sanitary and storm sewage consist of:

1. Rough screening to remove large boards, rocks, etc.

2. Screening on a fine mesh screen.

3. Disinfection by chlorination.

Five such facilities would be provided at appropriate locations. Each facility would receive overflows accumulated from several areas for treatment at that location. Overflow treatment should not alter the city's present policy of requiring separate sanitary and storm sewer systems for all developing areas.

The proposed facilities and their estimated costs are presented in Table XIII-A. Descriptions of each facility may be found in Chapter XI. Chapter XII presents alternative means for compliance with State requirements for secondary treatment of dry weather sewage flows from Spokane.

The total estimated cost for secondary treatment and overflow mitigation is $36,250,000, based on 1972 construction costs.

B. PRIORITIES

The following priorities are presented for construction of the recommended facilities. The order of construction within each priority category should be reviewed periodically. Costs of recommended facilities are tabulated in Table XIII-A, and their location is shown on Exhibit XIII-1

Priority I - Immediate

Upgrade sewage treatment plant (secondary treatment).

Erie Street Complex, Phase I (bypass elimination).

Priority II - Scheduled

Sewer separation program, overflow Points 1, 2 and 6.

Sewer separation program, overflow points 33 and 34.

CBD interceptors, overflow treatment facility, and downtown sewer repairs.

Erie Street Complex, Phase II overflow treatment facility and upstream interceptors.

North Bowl area interceptors and overflow treatment facility.

T. J. Meenach Drive interceptors and overflow treatment facility.

Hollywood area interceptors and STP overflow treatment facility.

Nutrient removal and storm relief for the northeast sector are optional or future construction items. Neither is included in the listed priorities or cost summary.

TABLE XIII-A

COST SUMMARY

Location - Project	Cost
Overflow Point No. 1 - Separate Storm Sewers	$300,000
Overflow Point No. 2 - Separate Storm Sewers	400,000
Overflow Point No. 6 - Separate Storm Sewers	450,000
Erie Street Complex -	
Overflow Points No. 3, 4, 5 - Overflow Interceptor	450,000
Overflow Point No. 8 - Overflow Interceptor	100,000
Overflow Points No. 9 through 14 - Phase I Bypass Elimination	500,000
Overflow Treatment Plant - Phase II	3,700,000
Total - Erie Street Complex	$4,750,000
Central Business District & Latah Creek	
Browne Street Interceptor	250,000
Freeway Stormwater Interceptor	1,800,000
Downtown Sewer Repairs	500,000
South Riverfront Overflow Interceptor	1,500,000
Latah Creek Overflow Treatment Facility	4,600,000
Total - CBD - Latah Creek Facilities	$8,650,000
North Bowl Area	
Trunk from Overflow Point No. 20	75,000
Overflow Interceptors Upstream from Stevens & Indiana	200,000
Indiana & Stevens to Division Overflow Interceptor	675,000
Division to Monroe Overflow Interceptor	850,000
Monroe to Cedar Overflow Interceptor	150,000
Cedar & Ide Overflow Treatment Facility	3,200,000
Total - North Bowl Area Facilities	$5,150,000

Location - Project	Cost
Overflow Points No. 33 & 34 - Separate Storm Sewers	$1,300,000
T. J. Meenach Drive Facilities	
Overflow Point No. 35 - Interceptor to T. J. Meenach Drive	500,000
Overflow Points No. 36 & 37 - Pipe & Overflow Treatment Facility	3,400,000
Total - T. J. Meenach Drive Facilities	$3,900,000
Hollywood Interceptor Complex	
Overflow Interceptor - Points 38 and 39	200,000
Overflow Interceptor - Points 40 through 44	150,000
Overflow Treatment Facility at STP Site	3,000,000
Total Hollywood Interceptor Complex	$3,350,000
Total - Overflow Mitigation	$28,250,000
Main Sewage Treatment Plant	
Add Secondary Treatment	8,000,000
Total	$36,250,000
Added Annual O & M Costs	
Overflow Treatment Facilities	
Erie Street Complex	70,000
Latah Creek	70,000
North Bowl - Cedar & Ide	50,000
T. J. Meenach Drive	50,000
STP Site	50,000
Secondary Treatment Facility	520,000
Total	$810,000

C. FINANCIAL CONSIDERATIONS

1. General

In June, 1971, the City of Spokane increased sewer service charges to produce additional revenue. The minimum residential rate was raised from $1.50/mo. to $3.50/mo. Commercial and industrial rates were appropriately increased. After a year of collecting the higher services charges, an anticipated net gain of $1 million per year for capital construction is now substantiated. It is the City's intent to maintain this $1 million annual addition to capital construction funds.

The construction program that can be carried by this rate structure depends on the following interrelated factors:

a. Construction cost of major elements.

2. Amount of State and Federal grant funds available, and schedule on which such funds will be delivered.

3. Time schedule desired for accomplishing major elements of the program, and projected total time to accomplish all recommended elements.

4. Escalation of present cost estimates due to delay in the start of construction.

The present level of Federal-State assistance is 45 percent of construction cost. Proposed legislation could increase this to between 60 and 90 percent.

2. Priority I - Immediate Construction

The total cost of Priority I facilities is estimated to be $9.9 million, including $1.4 million cost escalation at 8 percent per year for two years. Construction will not be complete until late 1974, with final payment in 1975. City revenue for capital improvements accumulated from 1971 to 1975 will be $4 million, leaving a minimum of $5.9 million, or 60 percent, required from grant funds. A somewhat longer time for accumulation of construction funds would be required if grant assistance continues at the present 45 percent level.

3. Priorities I and II Construction

By staging construction of Priority I and II items over the next ten years, the total construction cost will increase about $18.0 million, assuming an annual escalation rate of 8 percent. The total program would then cost an estimated $54 million. Grants totaling 80 percent of construction costs must be received to accomplish the program on a pay-as-you-go basis, with the $11 million to be accumulated from revenues over the period 1971-82. Construction schedule and revenue requirements are shown graphically on Figure XIII-1.

Earlier construction completion could be accomplished by bonding and subsequent repayment of bonds out of annual revenues.

One million dollars per year in revenue will allow the repayment of $14 million in bonds over thirty years at 6 percent interest. Nearly 70 percent grant funding would still be required to complete the construction program assuming that construction contracts can be let within five years. Costs would be escalated by an estimated $9.0 million during the five years from 1972 to 1977.

4. Rate Structure

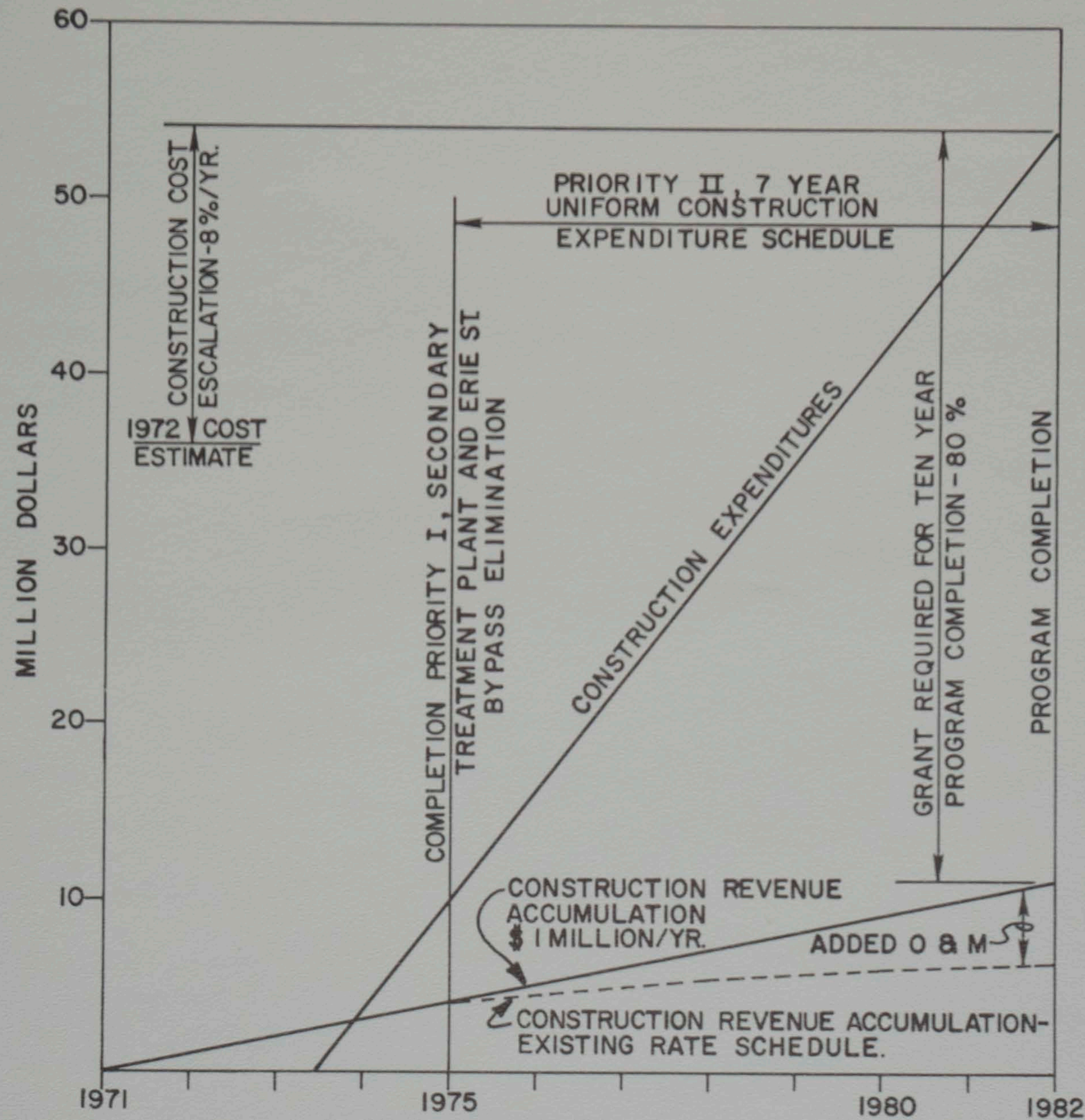
The present rate structure will not continue to provide $1 million per year in available construction funds after the major treatment facilities go into operation.

Construction funds will be reduced by the increase in operating costs of new facilities, estimated to be $520,000 per year for the upgraded main treatment plant, and $50,000 - $70,000 per year for each major overflow treatment facility. If the City's expressed intent to provide $1 million per year for capital improvements is to be realized for the ten-year period assumed, additional revenues must be obtained to cover the increase in O & M costs, starting in approximately 1975.

5. Summary

Priority I items can be constructed with grant programs at present levels, and with the present sewer charges. Financing Priority II items is not possible with the existing revenue collection rate and present grant programs.

Assuming a ten-year schedule to accomplish Priority I and II construction, local funds available for capital improvements will total $11 million. As major elements of the program will be deferred, total costs will increase due to inflation to an estimated $54 million. Grant funds must pay for 80 percent of the program if it is to be accomplished in a ten-year period.



REVENUE AND EXPENDITURES FOR A TEN YEAR CONSTRUCTION PERIOD

FIGURE XIII - I

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SPOKANE WASTEWATER STUDY

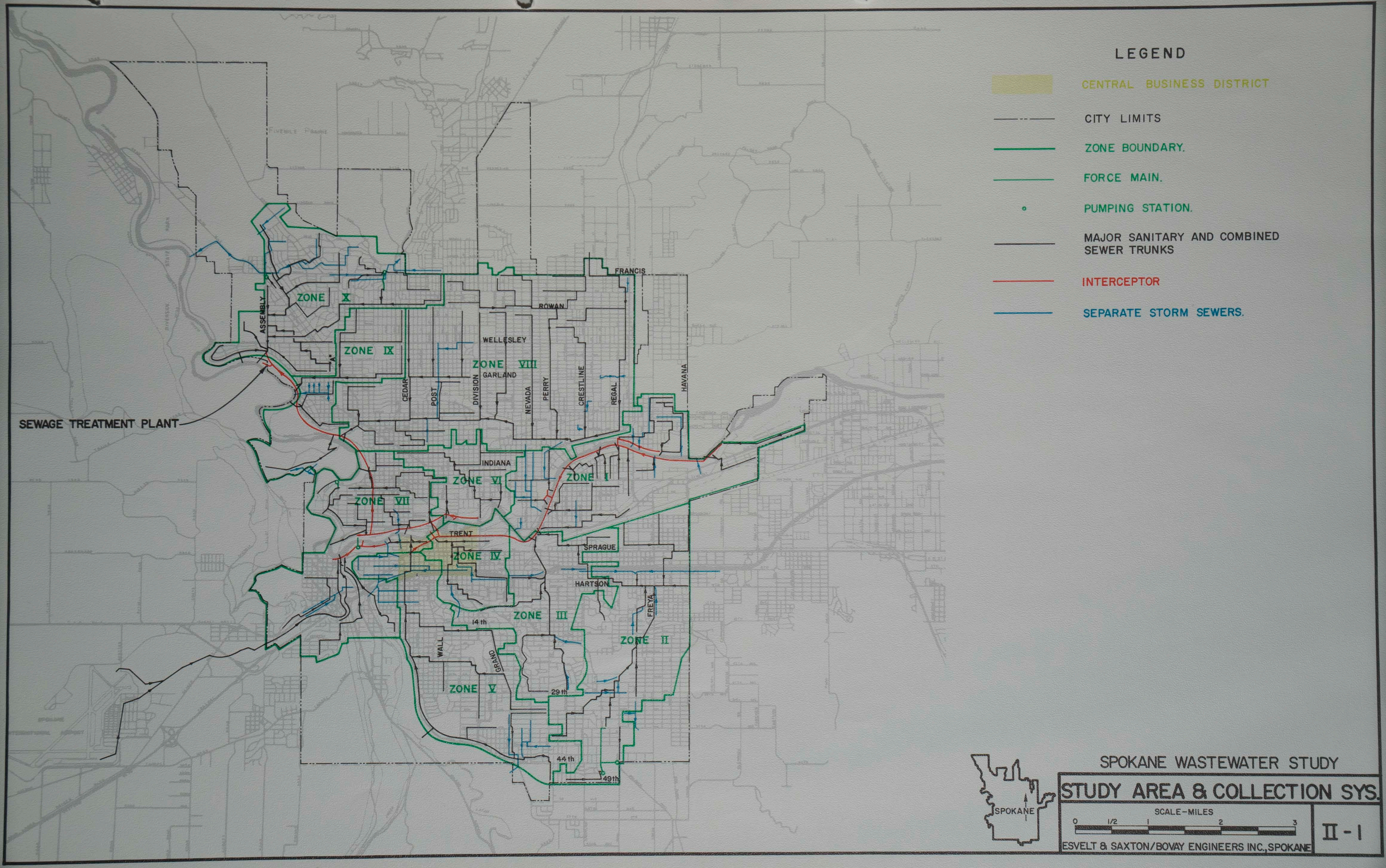
EXHIBITS

JULY 1972

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

EXHIBITS

Exhibit No.	Title
II-1	Study Area & Collection System
II-2	Existing Overflow Locations
II-3	Unsewered Areas
IV-1	Soils Distribution
IV-2	Population
IV-3	1970 Census Tracts
IV-4	General Zoning and Land Use
V-1	Spokane River
V-2	River Flow and Quality
V-3	River Quality, DO & BOD
V-4	River Quality, N & P
V-5	River Quality, NO_3 & NH_3
VI-1A	Storm Drainage System - Zone I
VI-1	Sanitary Sewage Collection System - Zone I
VI-2A	Storm Drainage System - Zones II & III
VI-2	Sanitary Sewage Collection System - Zones II & III
VI-3A	Storm Drainage System - Zones IV & V
VI-3	Sanitary Sewage Collection System - Zones IV & V
VI-4A	Storm Drainage System - Zones VI & VII
VI-4	Sanitary Sewage Collection System - Zones VI & VII
VI-5A	Storm Drainage System - Zone VIII
VI-5	Sanitary Sewage Collection System - Zone VIII
VI-6A	Storm Drainage System - Zone IX
VI-6	Sanitary Sewage Collection System - Zone IX
VI-7A	Storm Drainage System - Zone X
VI-7	Sanitary Sewage Collection System - Zone X
VI-8	Existing Sewage Treatment Plant (STP)
VI-9	Existing STP - Performance (Figures 1, 2, 3, 4)
VI-10	Existing STP - Performance (Figures 5, 6, 7)
VI-11	Existing STP - Performance (Figures 8, 9)
VII-1	Rainfall Runoff
VII-2	Interceptor Flows (Sheets A through D)
VII-3	Overflow Calculations
VII-4	Overflow Tabulation
IX-1	Overflow Quality
IX-2	Comparative Runoff Quality
XI-1	Overflow Treatment Schematic
XI-2	Erie Street Complex
XI-3	CBD Improvements
XI-4	Latah Creek
XI-5	North Bowl Area
XI-6	Cedar & Ide
XI-7	T. J. Meenach Drive
XI-8	Hollywood Interceptor Complex
XI-9	N. E. Storm Relief
XII-1	STP Upgrading - Expanded Site
XII-2	STP Upgrading - Across River
XII-3	STP Upgrading - Existing Site
XIII-1	Recommended Facilities


LEGEND
CENTRAL BUSINESS DISTRICT
CITY LIMITS
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
MAJOR SANITARY AND COMBINED SEWER TRUNKS
INTERCEPTOR
SEPARATE STORM SEWERS.
SEWAGE TREATMENT PLANT
ZONE I
ZONE II
ZONE III
ZONE IV
ZONE V
ZONE VI
ZONE VII
ZONE VIII
ZONE IX
ZONE X
FRANCIS
ROWAN
WELLESLEY
GARLAND
ASSEMBLY
CEDAR
POST
DIVISION
NEVADA
PERRY
CRESTLINE
REGAL
HAVANA
INDIANA
TRENT
SPRAGUE
HARTSON
FREYA
14th
29th
44th
49th
WALL
GRAND
SPOKANE
SPOKANE WASTEWATER STUDY
STUDY AREA & COLLECTION SYS.
SCALE-MILES
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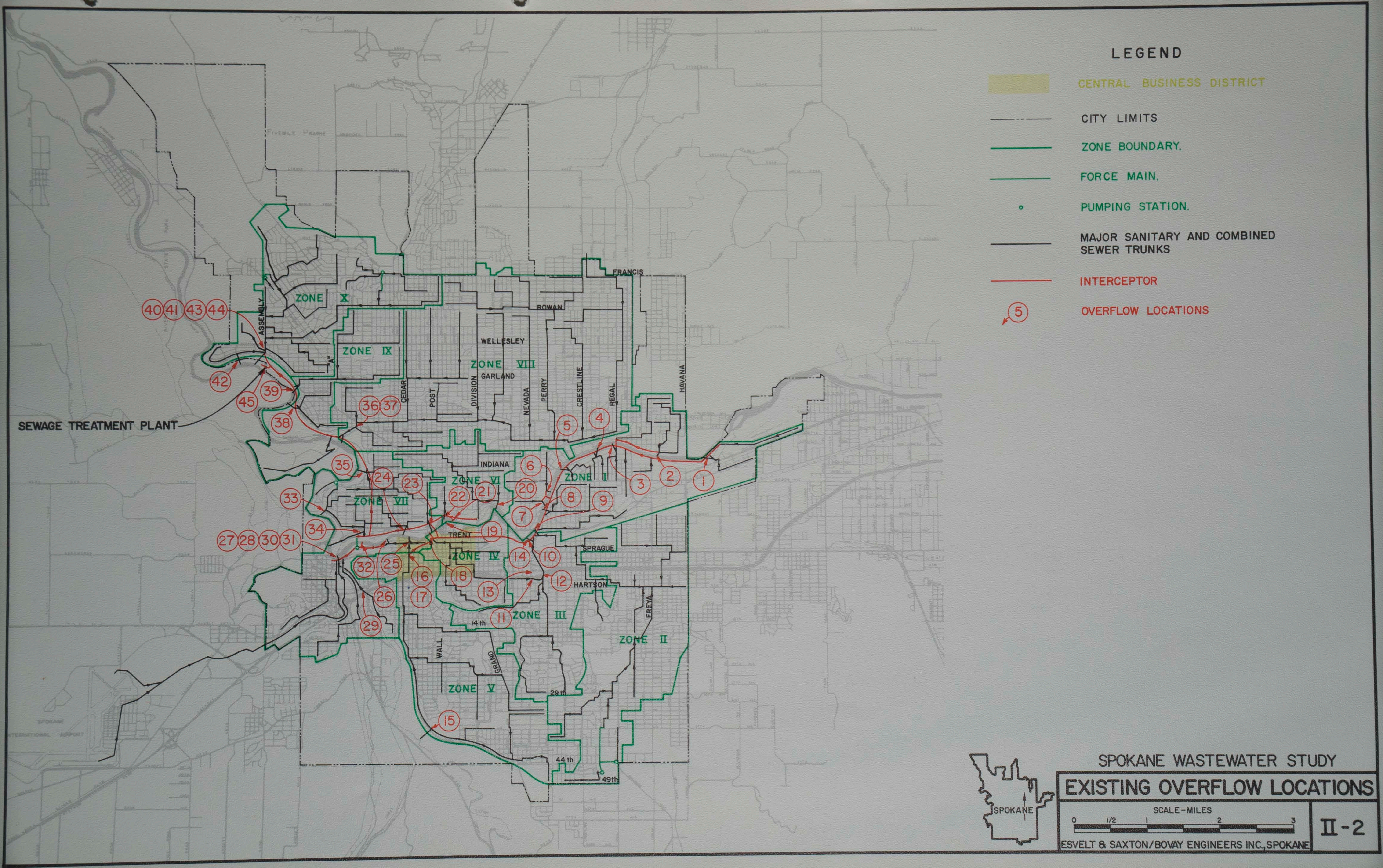
II-1
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

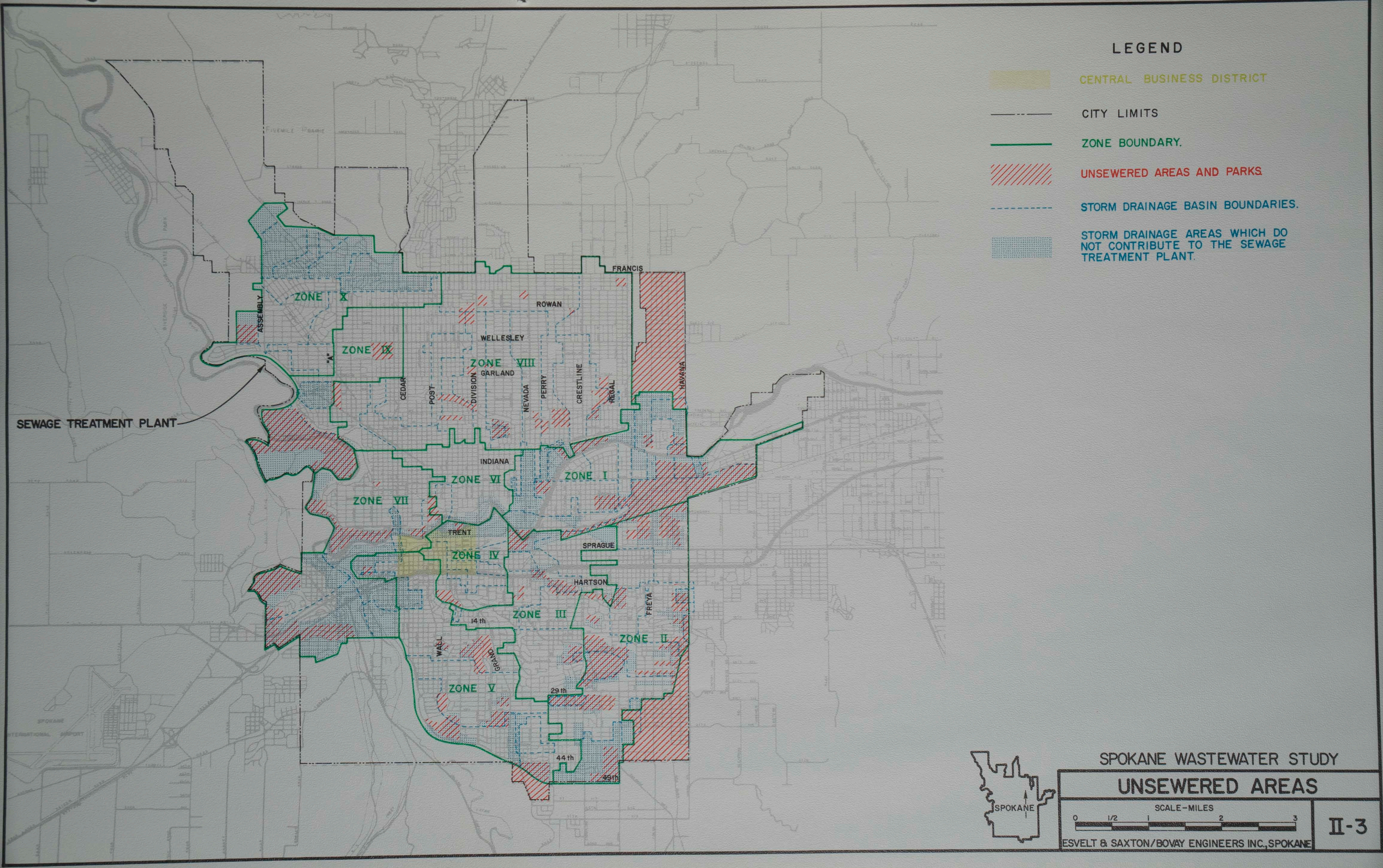


SPOKANE WASTEWATER STUDY

EXISTING OVERFLOW LOCATIONS

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

II-2

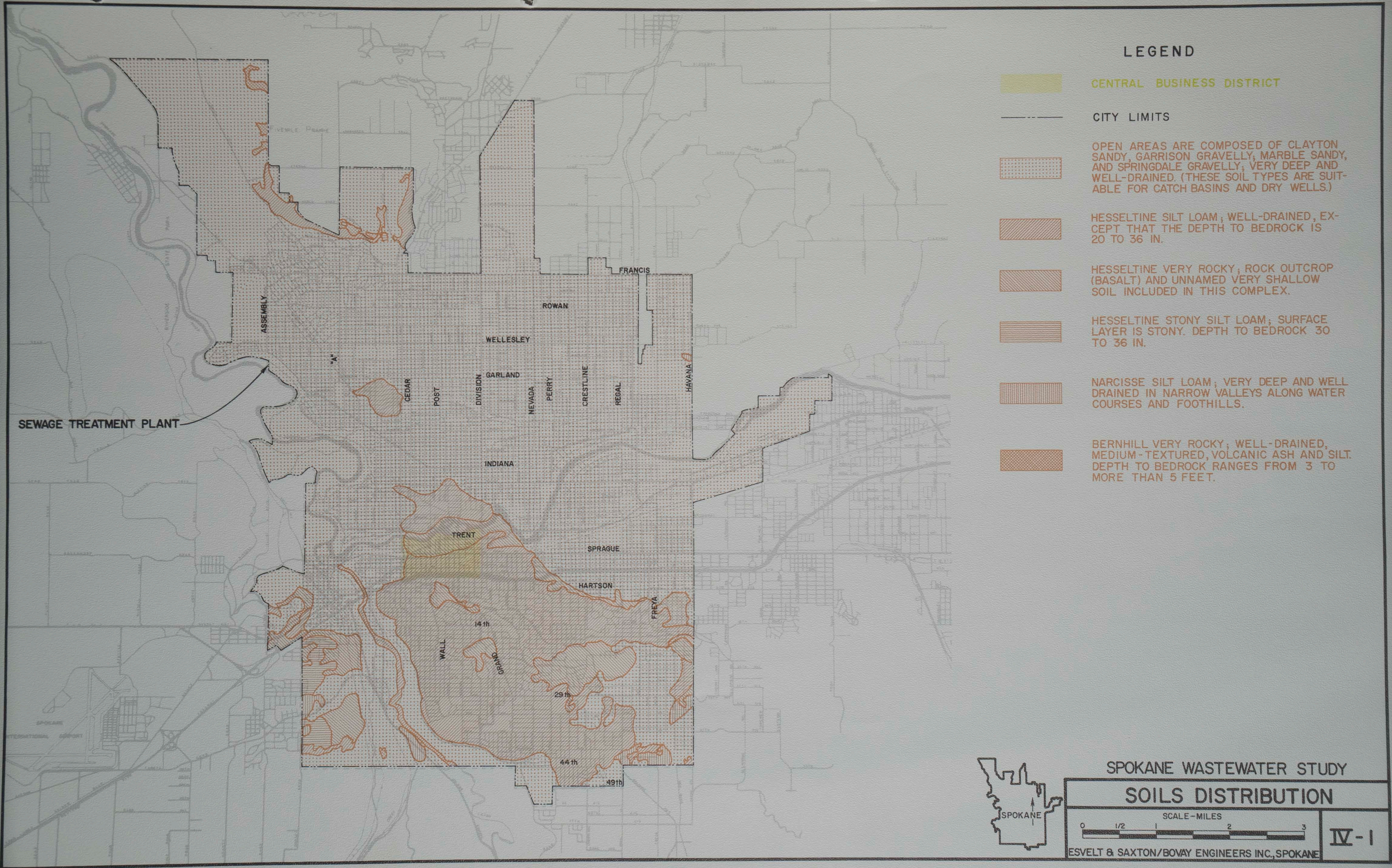


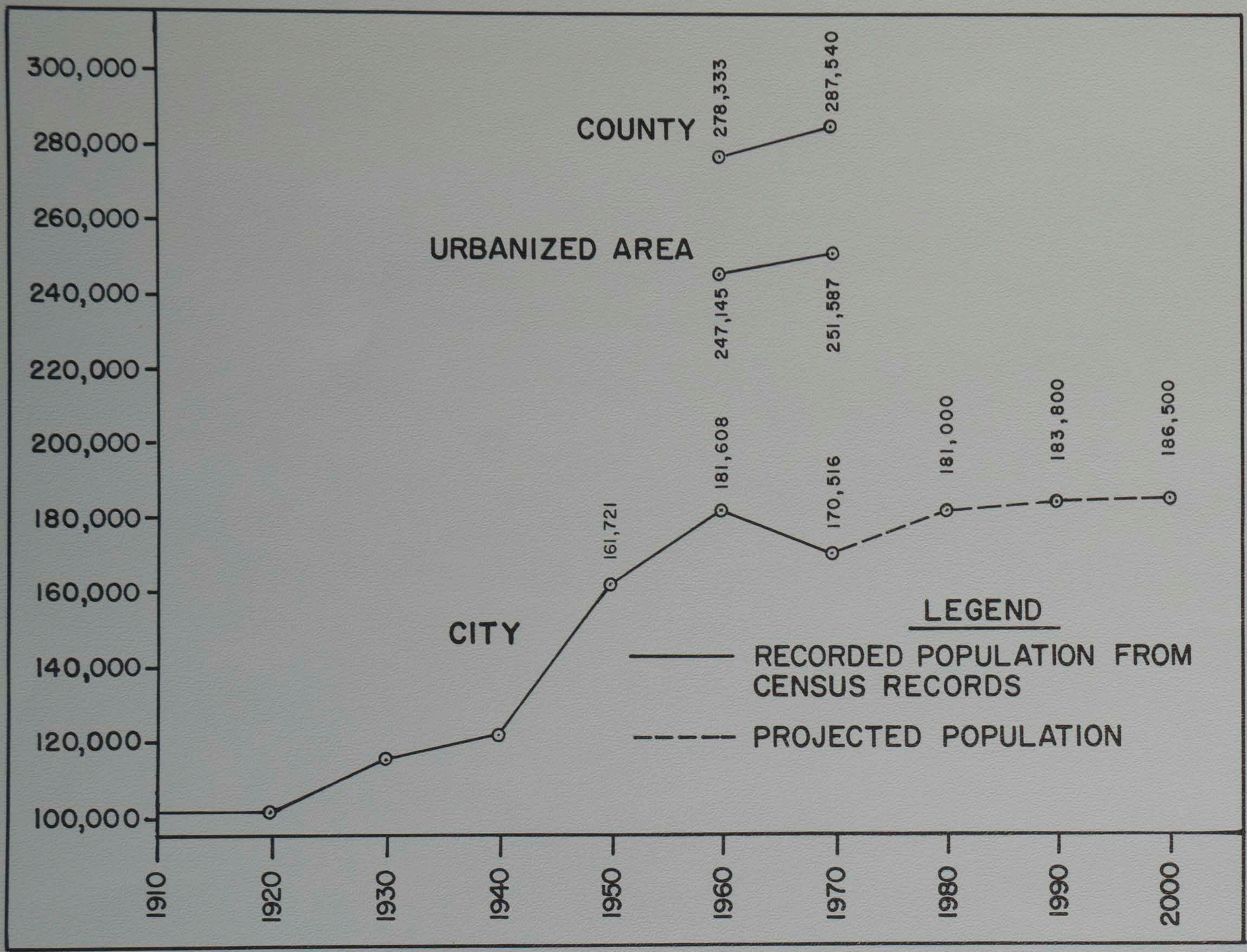
SPOKANE WASTEWATER STUDY

UNSEWERED AREAS

ESVELT & SAXTON/BOVAY ENGINEERS INC.,SPOKANE

II-3


LEGEND
CENTRAL BUSINESS DISTRICT
CITY LIMITS
OPEN AREAS ARE COMPOSED OF CLAYTON SANDY, GARRISON GRAVELLY, MARBLE SANDY, AND SPRINGDALE GRAVELLY; VERY DEEP AND WELL-DRAINED. (THESE SOIL TYPES ARE SUITABLE FOR CATCH BASINS AND DRY WELLS.)
HESSELTINE SILT LOAM; WELL-DRAINED, EXCEPT THAT THE DEPTH TO BEDROCK IS 20 TO 36 IN.
HESSELTINE VERY ROCKY; ROCK OUTCROP (BASALT) AND UNNAMED VERY SHALLOW SOIL INCLUDED IN THIS COMPLEX.
HESSELTINE STONY SILT LOAM; SURFACE LAYER IS STONY. DEPTH TO BEDROCK 30 TO 36 IN.
NARCISSE SILT LOAM; VERY DEEP AND WELL DRAINED IN NARROW VALLEYS ALONG WATER COURSES AND FOOTHILLS.
BERNHILL VERY ROCKY; WELL-DRAINED, MEDIUM-TEXTURED, VOLCANIC ASH AND SILT. DEPTH TO BEDROCK RANGES FROM 3 TO MORE THAN 5 FEET.
SEWAGE TREATMENT PLANT
ASSEMBLY
"A"
CEDAR
POST
DIVISION
GARLAND
NEVADA
PERRY
CRESTLINE
REGAL
HAVANA
FRANCIS
ROWAN
WELLESLEY
INDIANA
TRENT
SPRAGUE
HARTSON
FREYA
14th
WALL
GRAND
29th
44th
49th
SPOKANE
SPOKANE WASTEWATER STUDY
SOILS DISTRIBUTION
SCALE-MILES
0 1/2 1 2 3
IV-1
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE



City of Spokane

POPULATION HISTORY AND PROJECTIONS

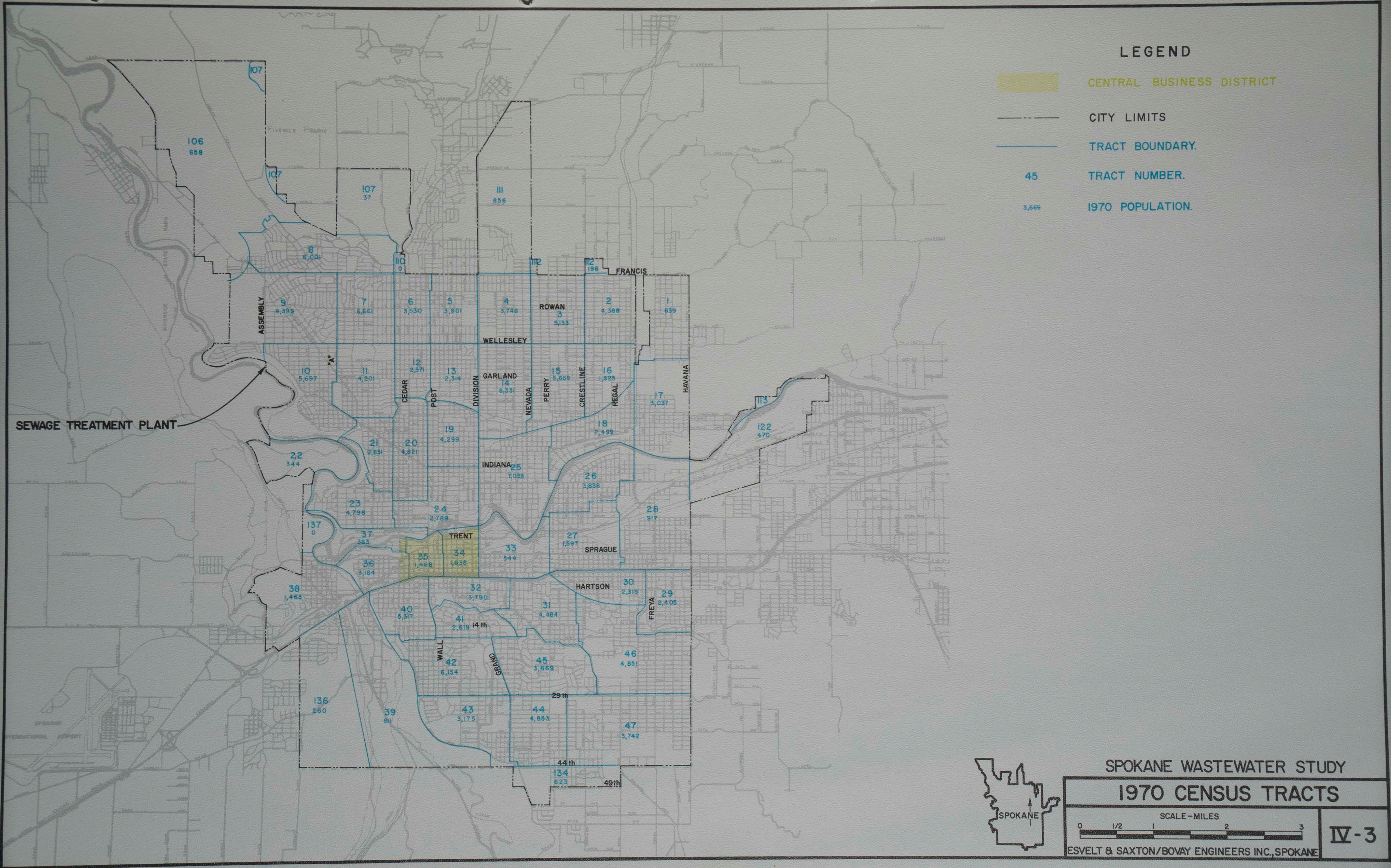
DISTRIBUTION OF CENSUS AND PROJECTED POPULATION

ZONE \ YEAR	1960	1970	1980	1990	2000
I	12,514	11,815	12,000	12,100	12,200
II	14,792	14,687	17,400	18,200	19,000
III	12,175	10,669	11,500	11,700	12,000
IV	3,457	2,815	2,800	2,800	2,800
V	23,386	22,695	23,800	24,200	24,600
VI	6,571	5,740	5,700	5,700	5,700
VII	14,559	12,087	12,700	12,900	13,100
VIII	54,060	47,710	50,900	51,200	51,600
IX	9,477	8,664	9,500	9,600	9,700
X	19,818	23,229	26,100	26,900	27,800

SPOKANE WASTEWATER STUDY

POPULATION

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

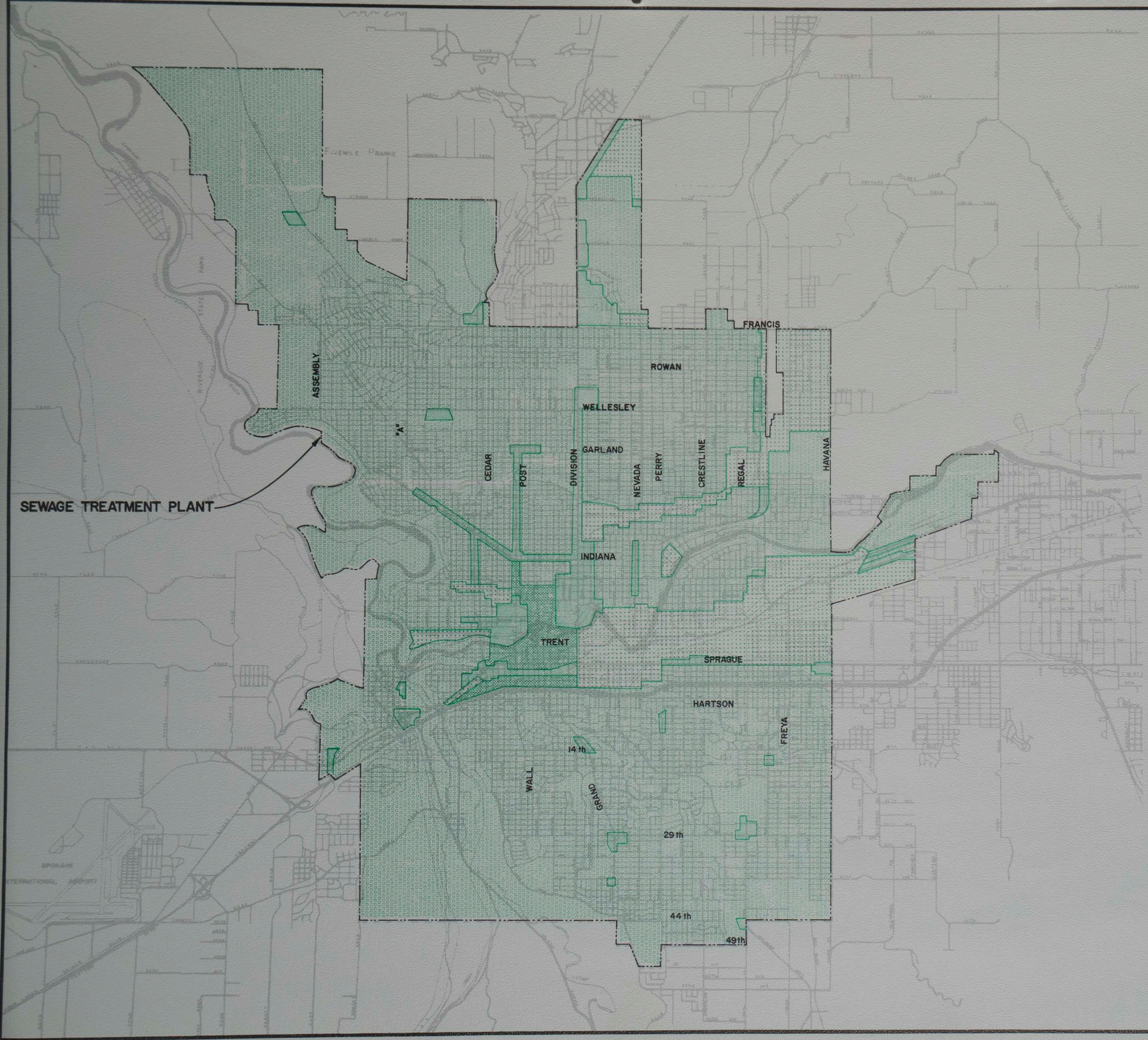


SPOKANE WASTEWATER STUDY

1970 CENSUS TRACTS

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

IV-3



LEGEND

CITY LIMITS

RESIDENTIAL; R1,R1-S,R2,R3,R4,RO.

BUSINESS & COMMERCIAL; B1,B2,C1.

BUSINESS DISTRICT; B3.

MANUFACTURING; M1,M2,M3.

SPOKANE WASTEWATER STUDY

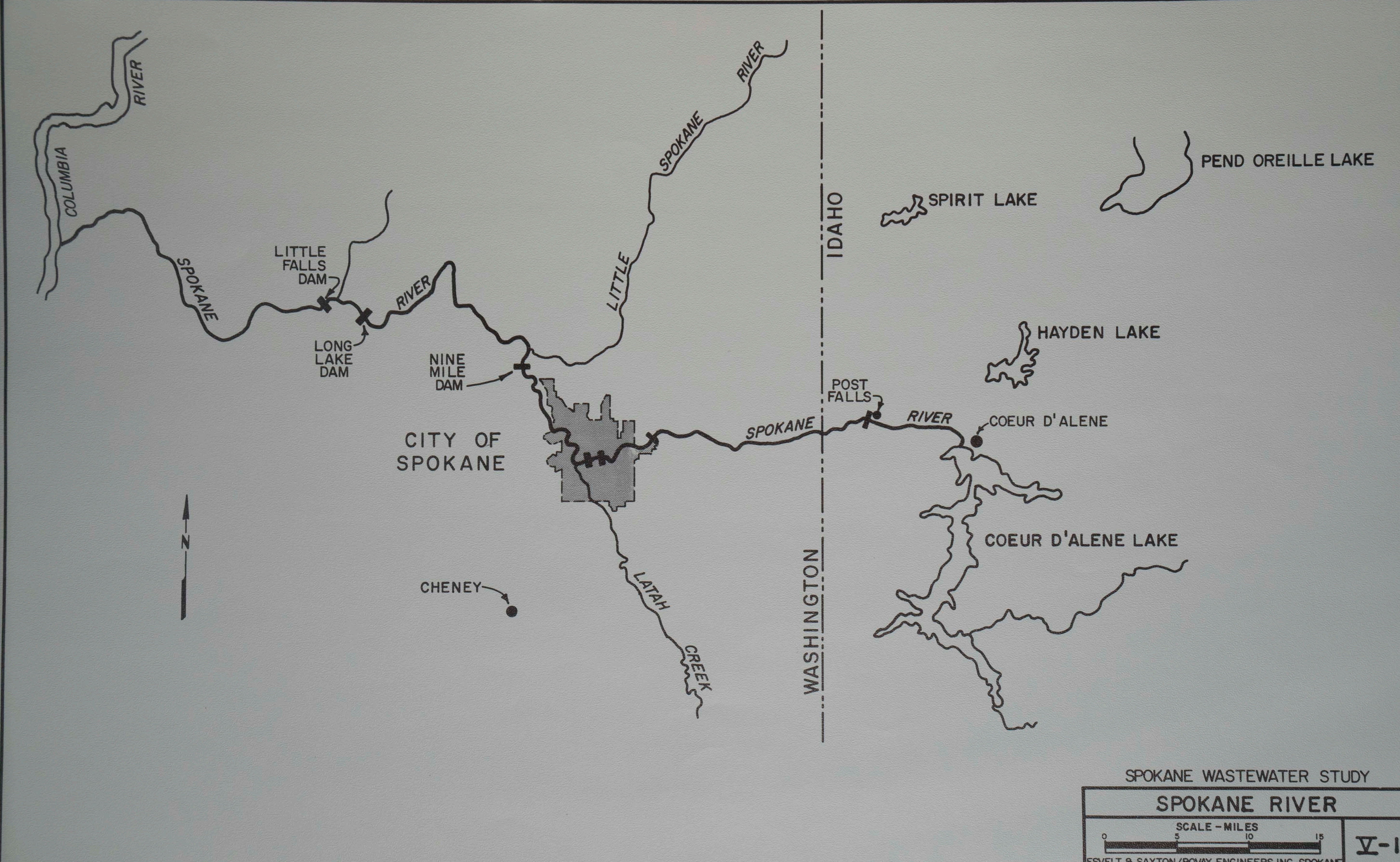
GENERAL ZONING & LAND USE

SPOKANE

SCALE-MILES 0 1/2 1 2 3

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

IV-4

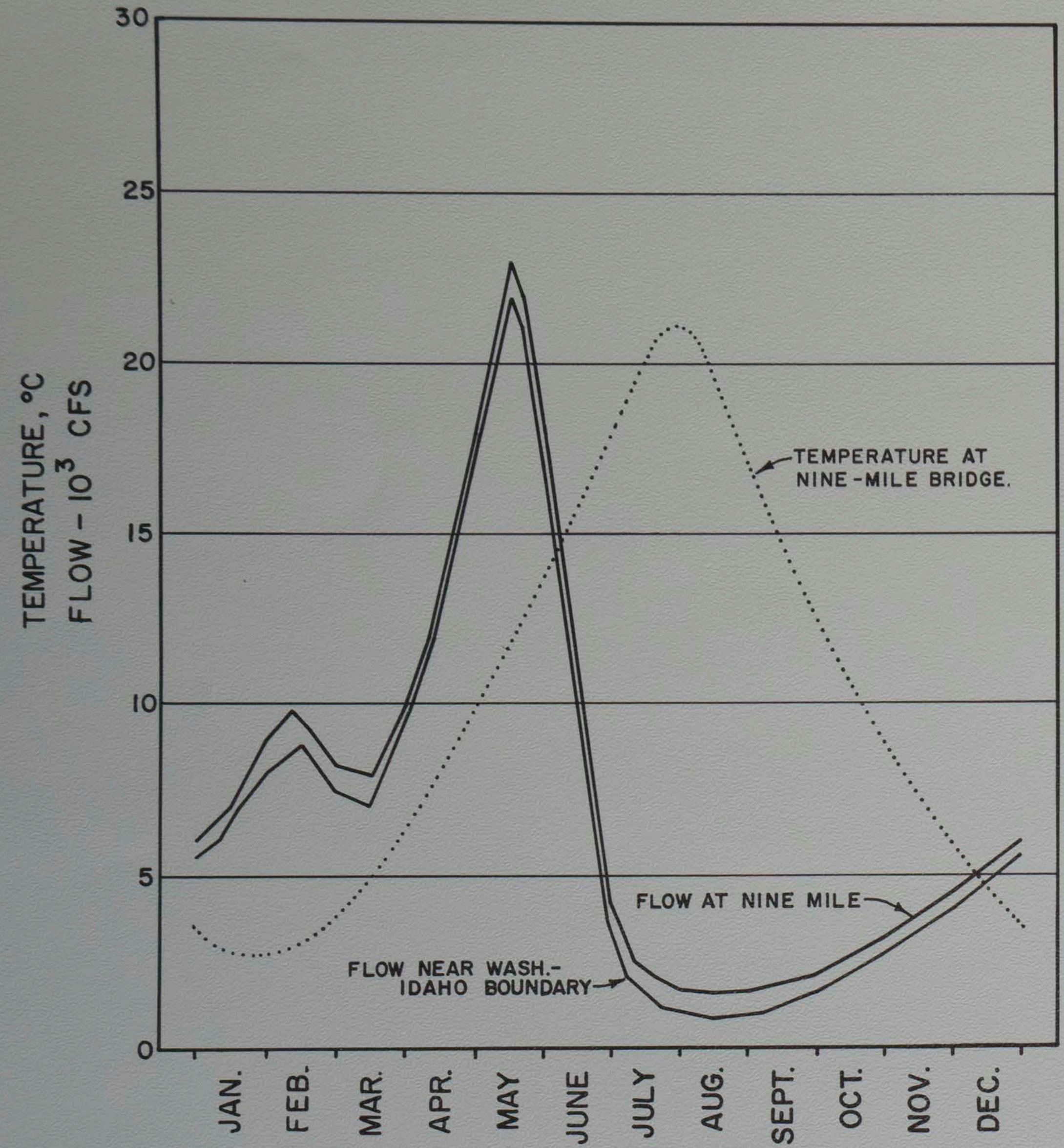


SPOKANE WASTEWATER STUDY

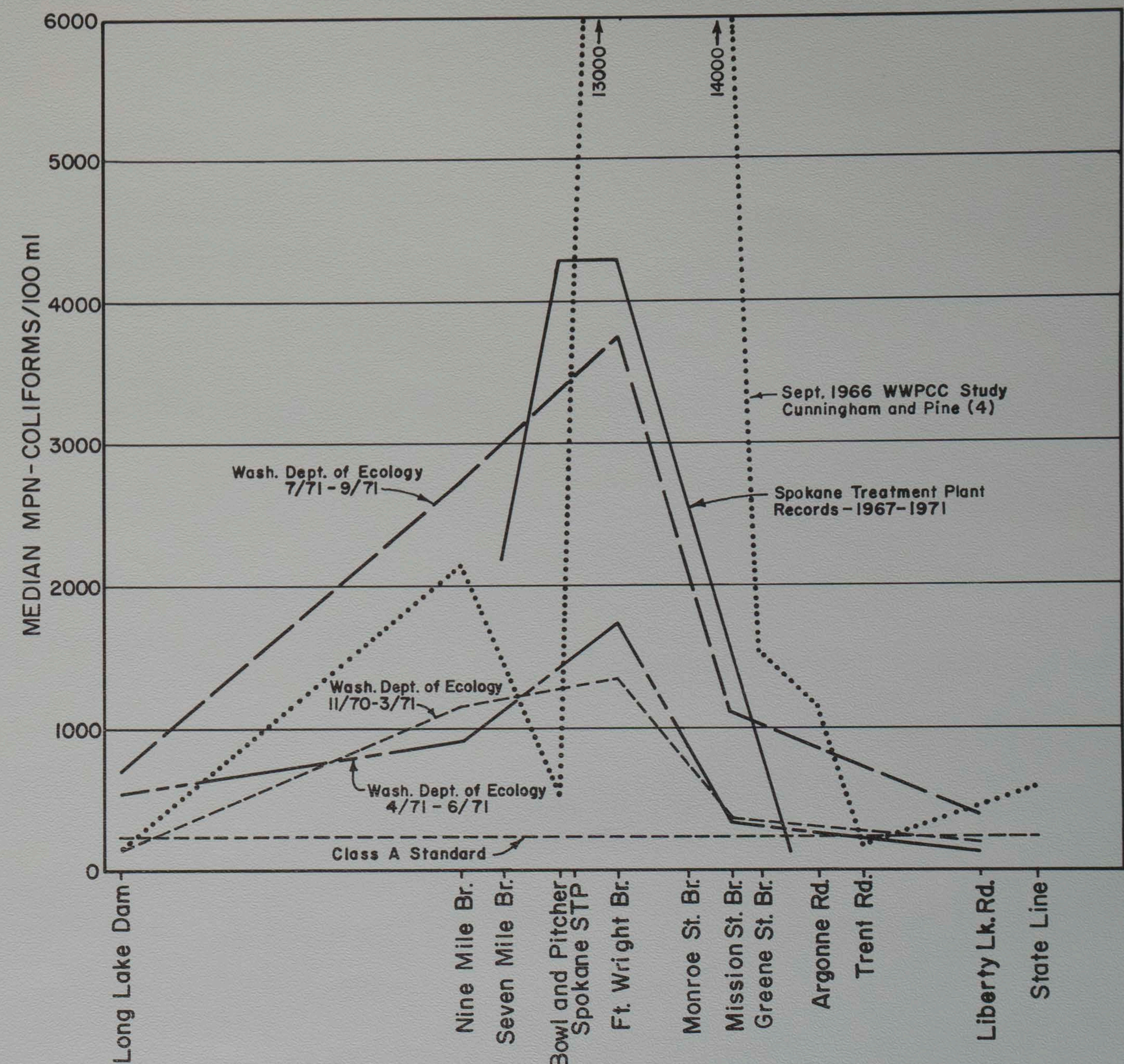
SPOKANE RIVER

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

V-1



AVERAGE ANNUAL FLOW FLUCTUATION AND TEMPERATURE. 1966-1971



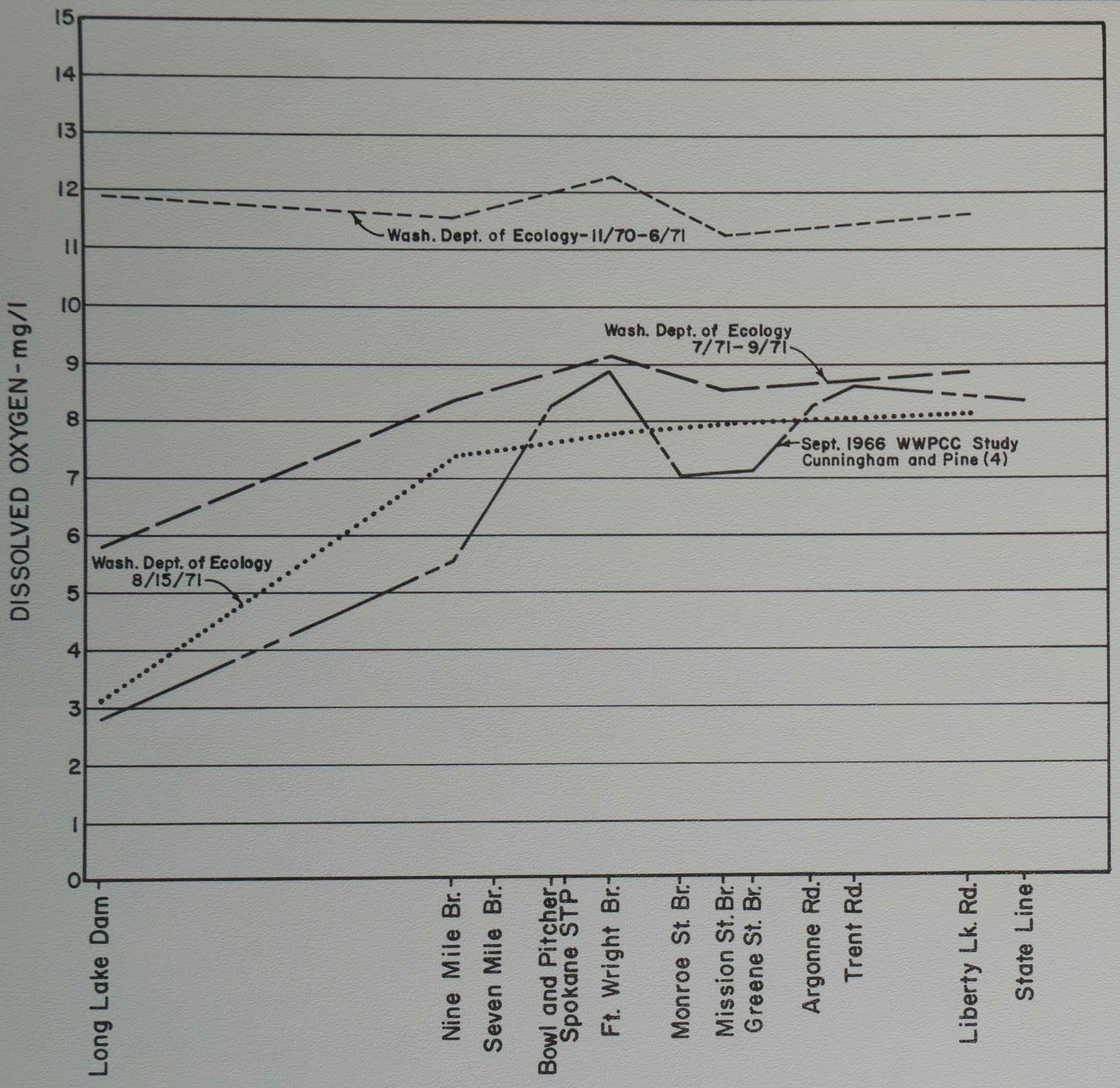
COLIFORM LEVELS

SPOKANE WASTEWATER STUDY

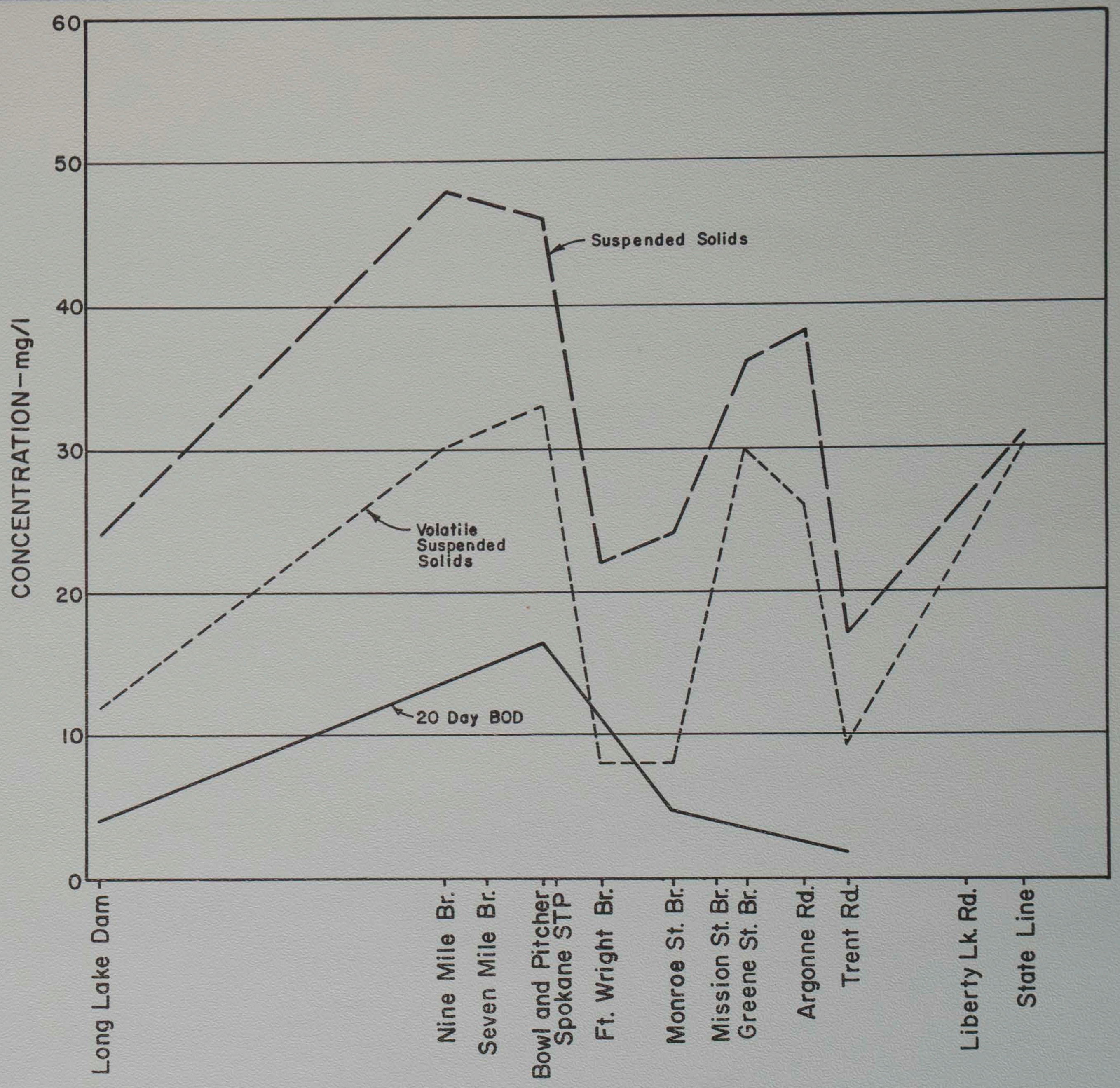
RIVER FLOW AND QUALITY

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

V-2



DISSOLVED OXYGEN LEVELS



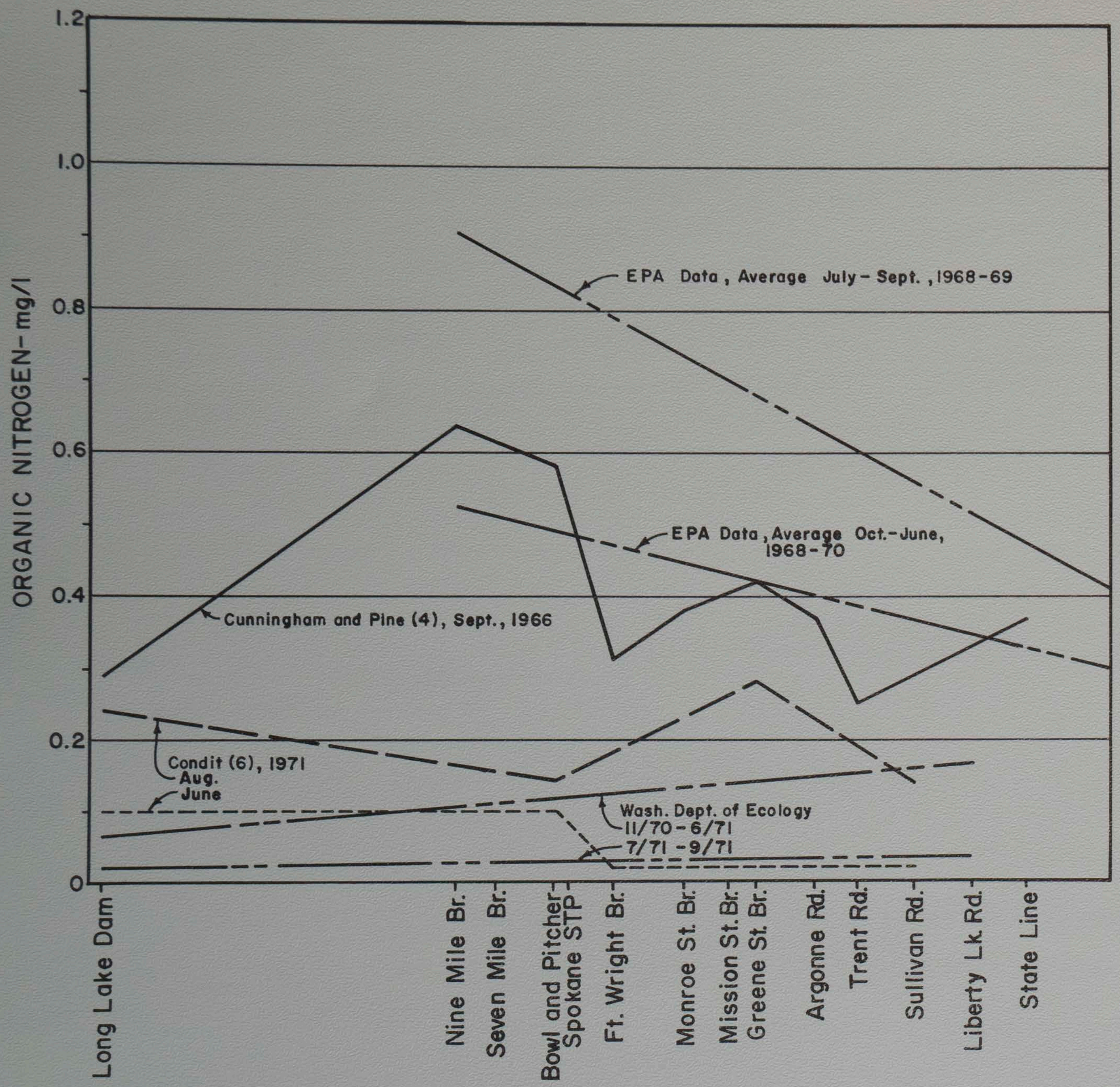
SOLIDS AND BOD LEVELS
SEPT. 1966 CUNNINGHAM & PINES (4)

SPOKANE WASTEWATER STUDY

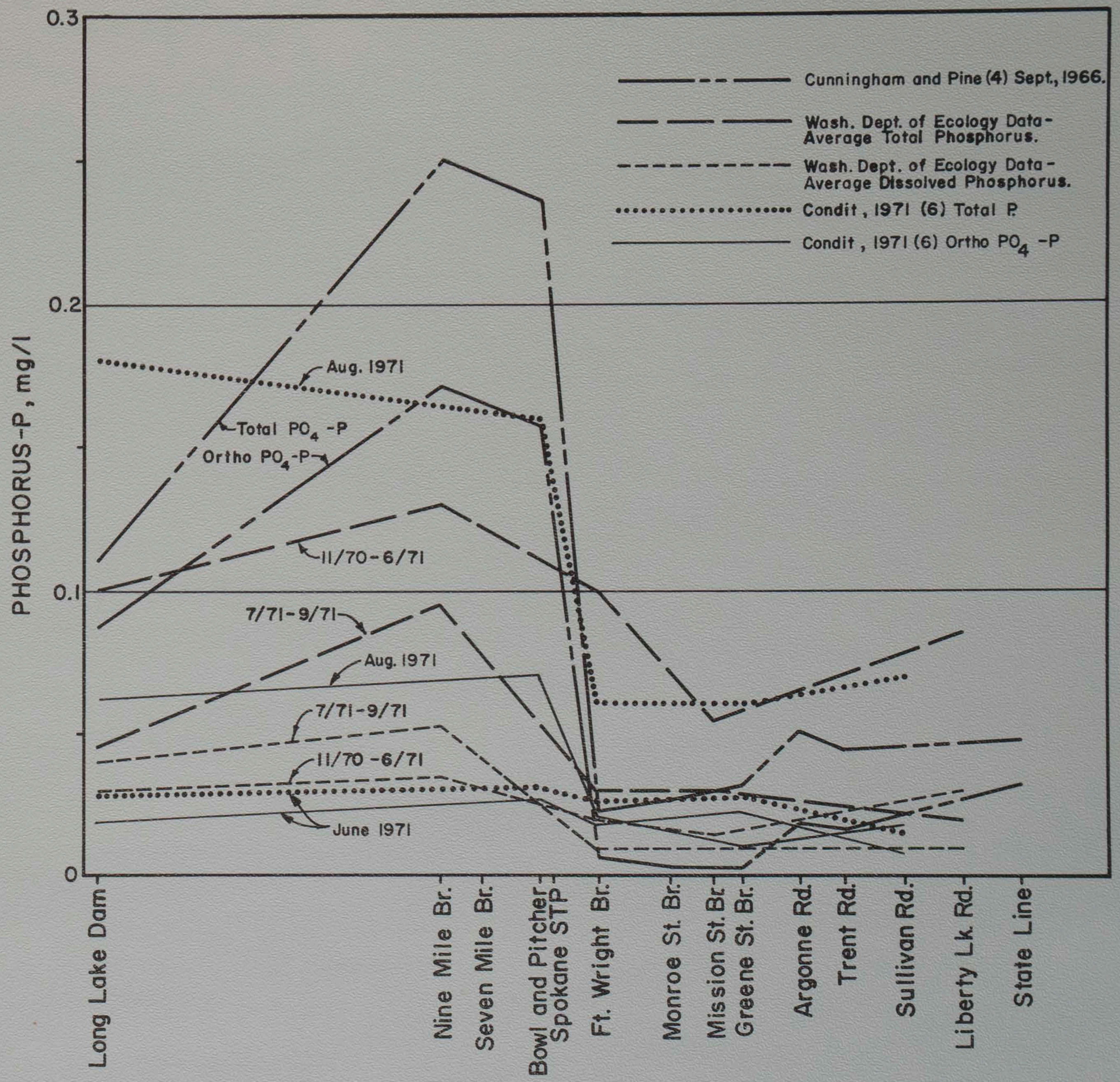
RIVER QUALITY, DO & BOD

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

V-3



ORGANIC N LEVELS



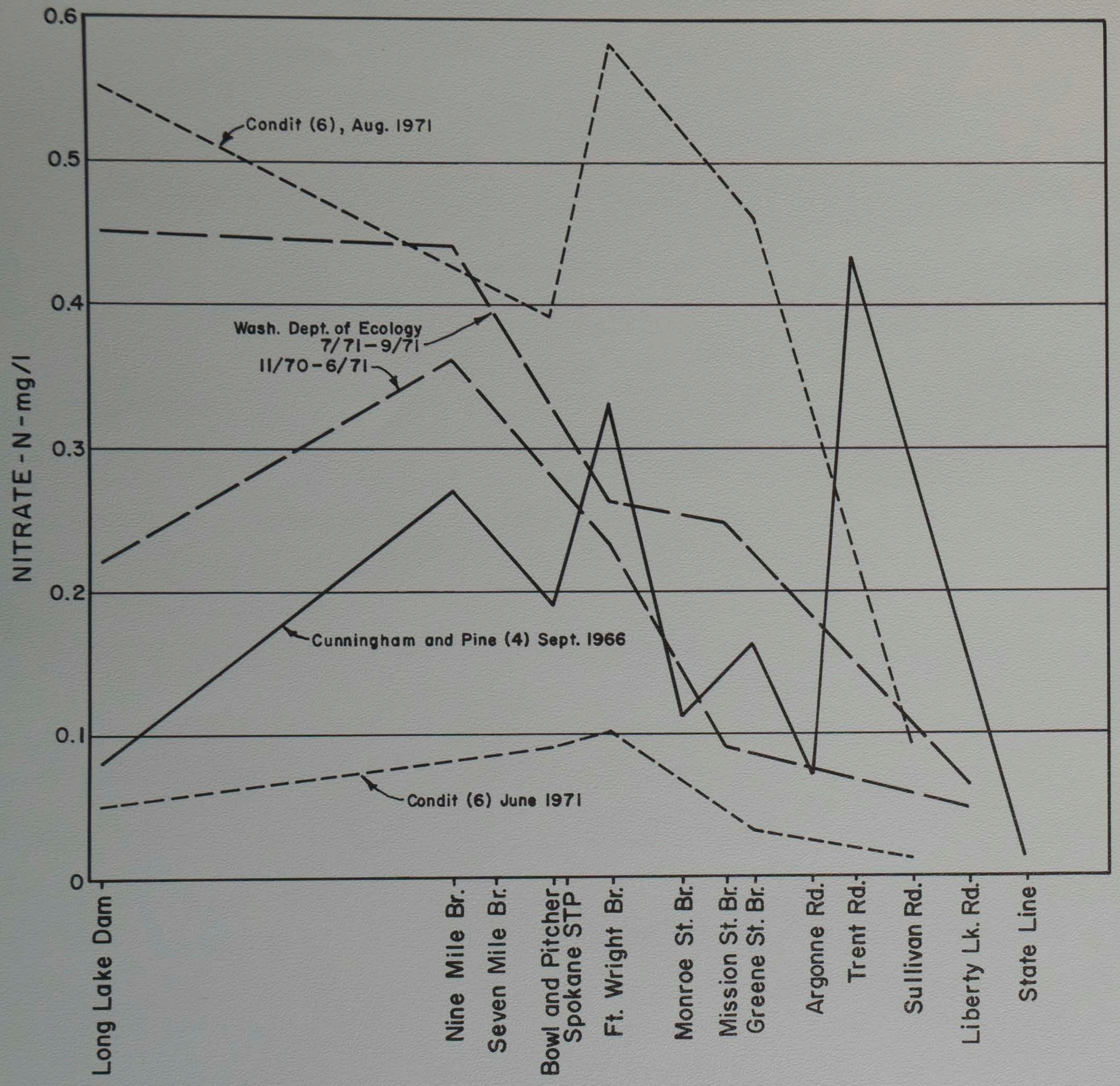
PHOSPHORUS LEVELS

SPOKANE WASTEWATER STUDY

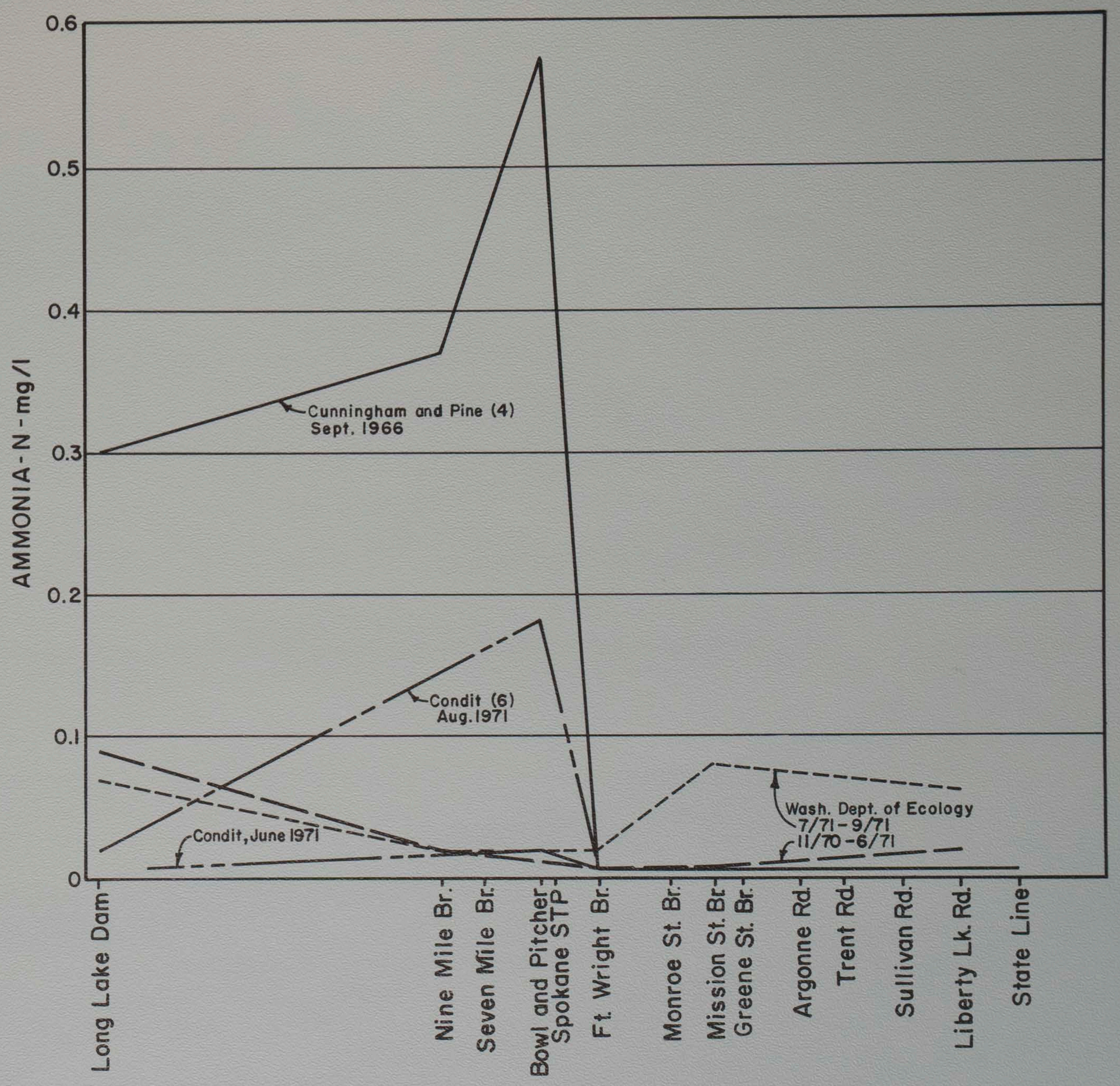
RIVER QUALITY, N & P

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

V-4



NITRATE - N LEVELS



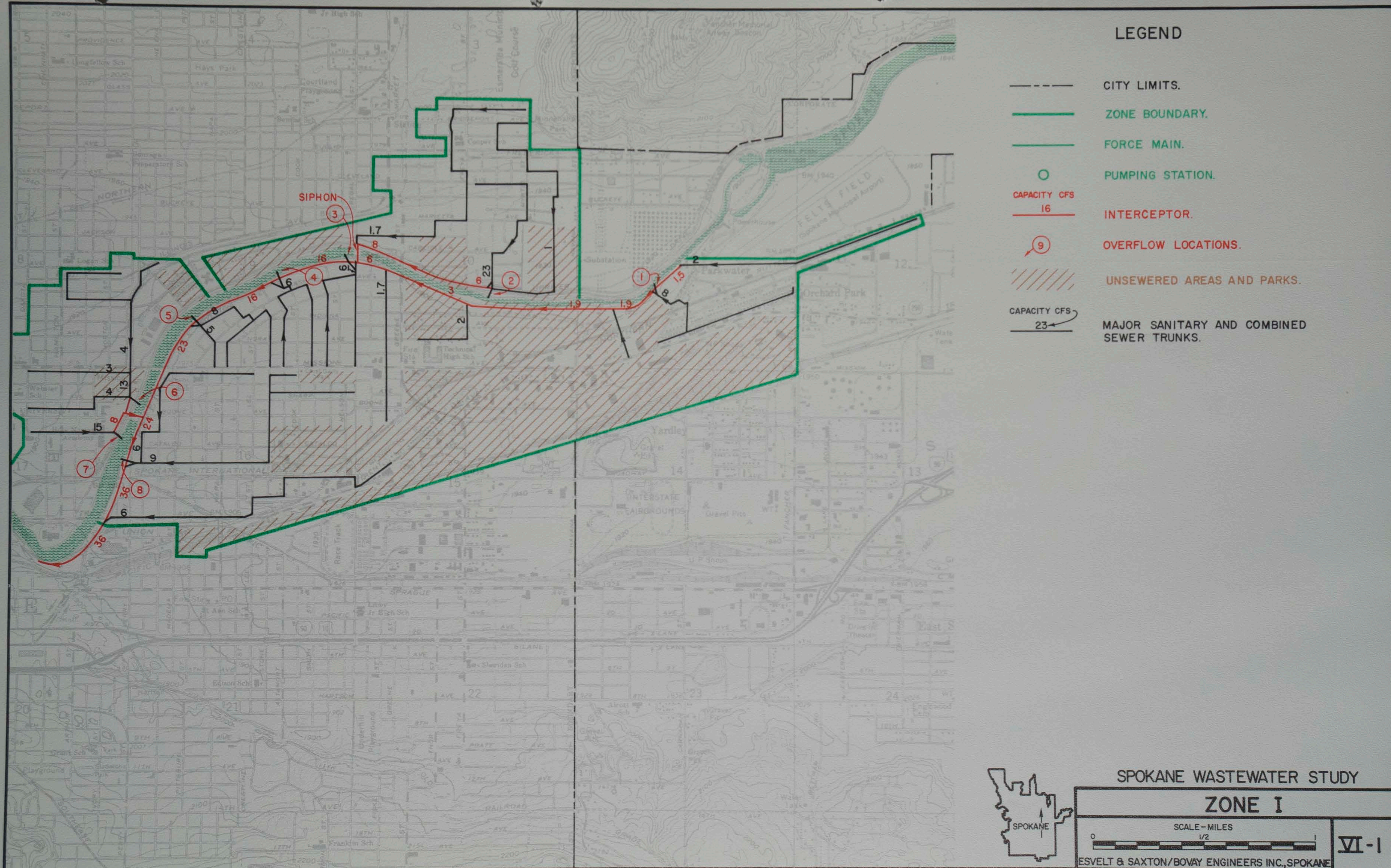
AMMONIA - N LEVELS

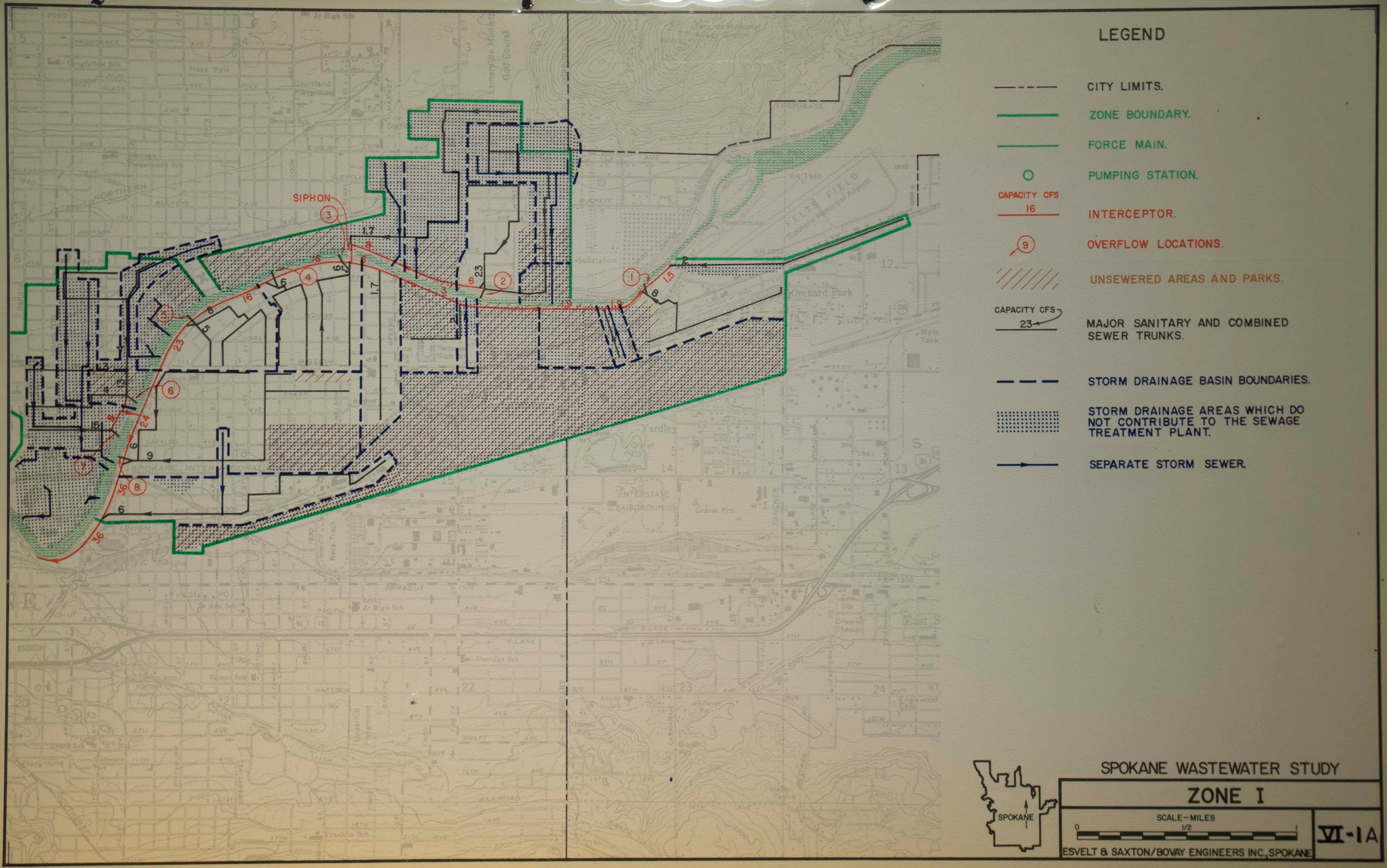
SPOKANE WASTEWATER STUDY

RIVER QUALITY, NO_3 & NH_3

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

V-5

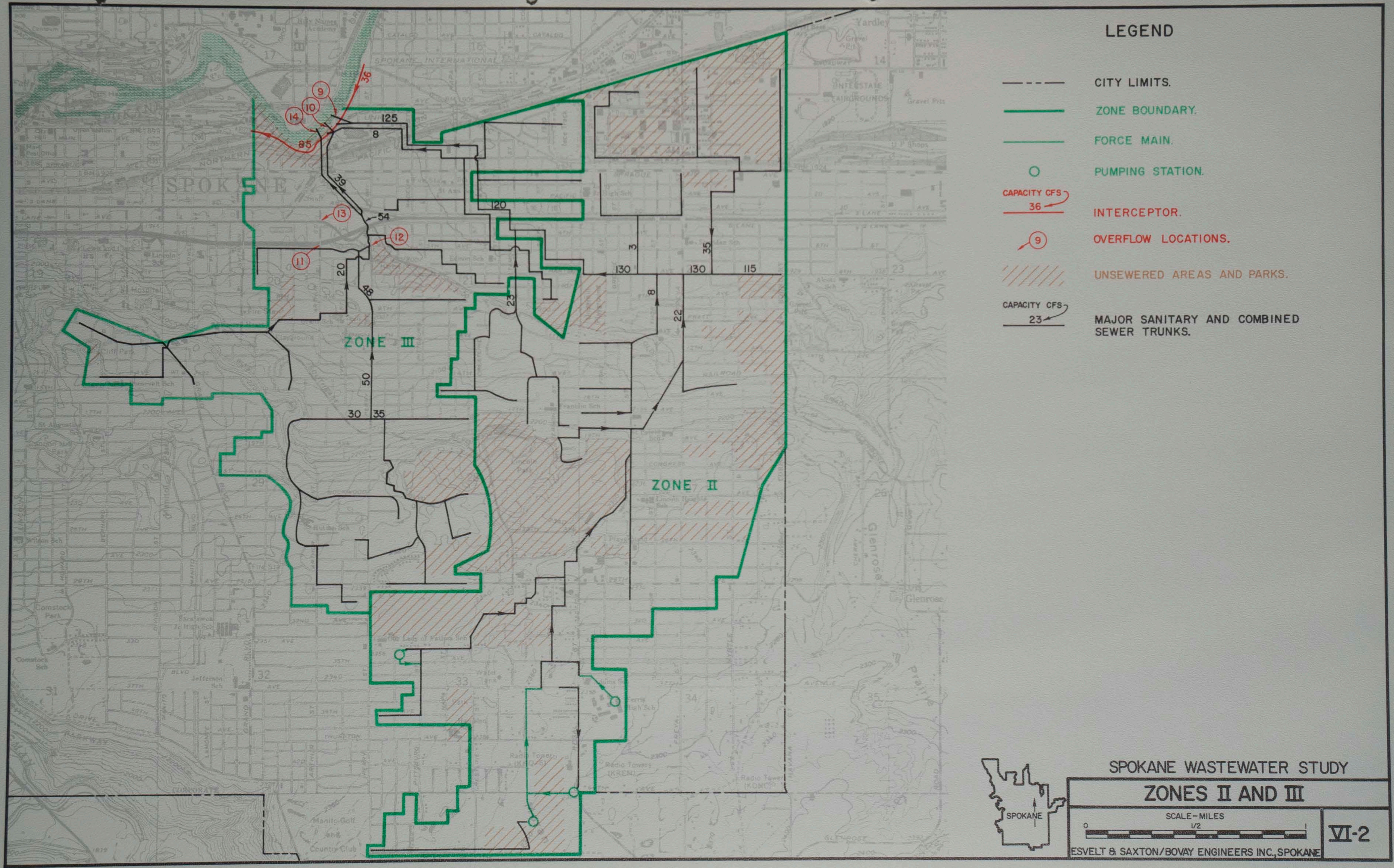

LEGEND
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
CAPACITY CFS
16
INTERCEPTOR.
9
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS
23
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
SIPHON
SPOKANE
SPOKANE WASTEWATER STUDY
ZONE I
SCALE-MILES
0
1/2
1
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
VI-1

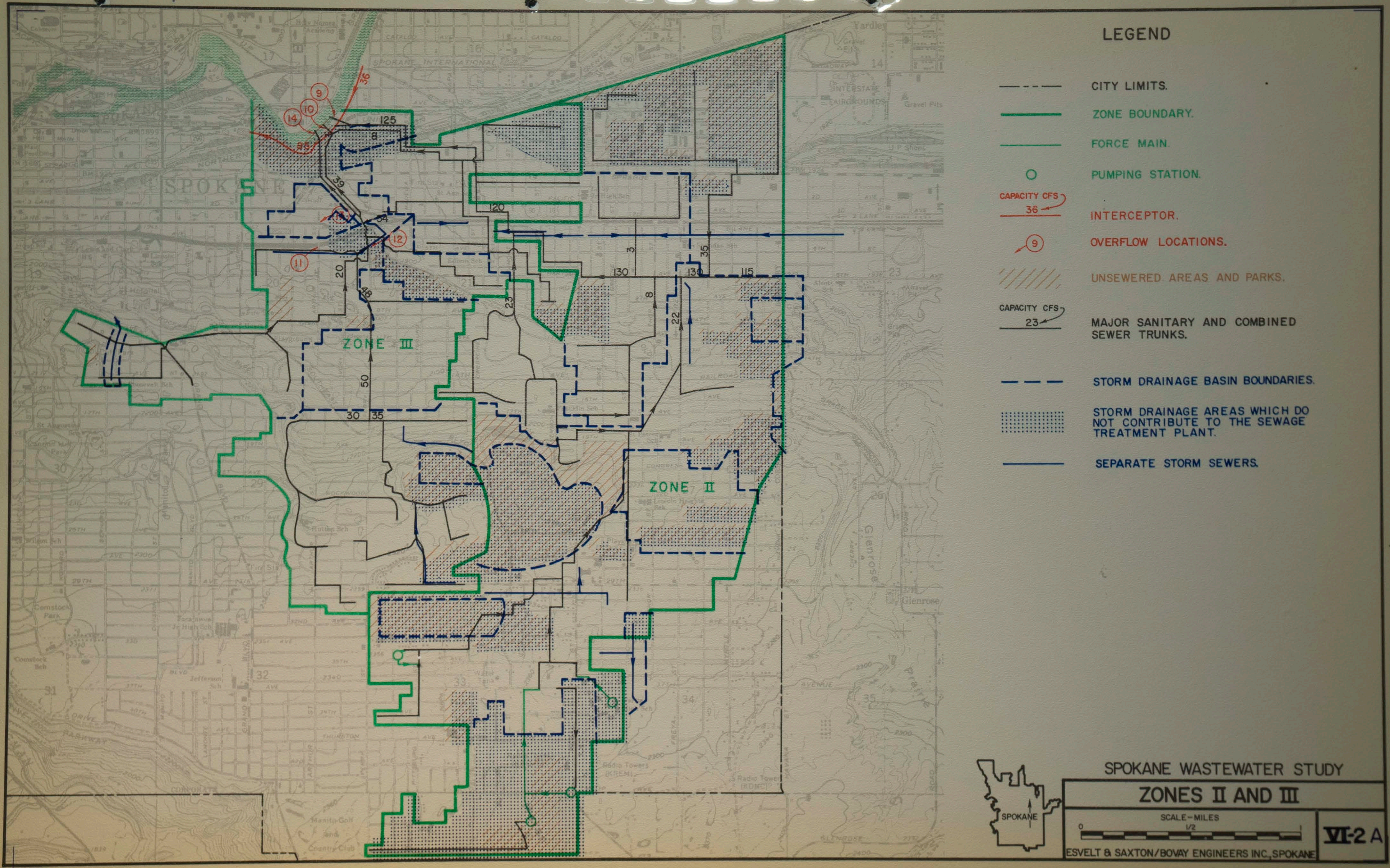


SPOKANE WASTEWATER STUDY

ZONE I

VI-1A


LEGEND
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
CAPACITY CFS
36
INTERCEPTOR.
9
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS
23
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
ZONE III
ZONE II
SPOKANE
SPOKANE WASTEWATER STUDY
ZONES II AND III
SCALE-MILES
0
1/2
1
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
VI-2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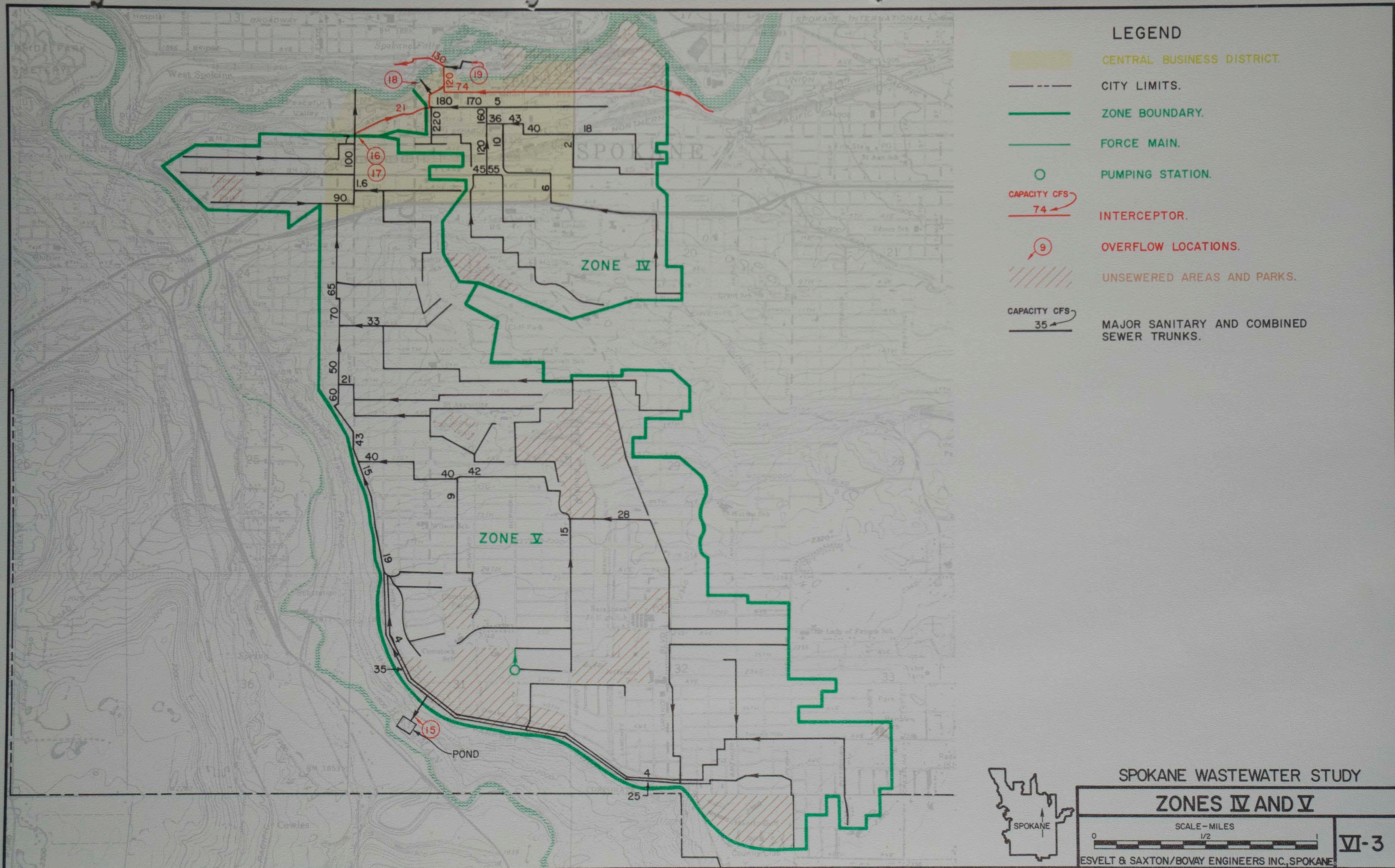
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
CAPACITY CFS 36
INTERCEPTOR.
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS 23
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
STORM DRAINAGE BASIN BOUNDARIES.
STORM DRAINAGE AREAS WHICH DO NOT CONTRIBUTE TO THE SEWAGE TREATMENT PLANT.
SEPARATE STORM SEWERS.
ZONE III
ZONE II
SPOKANE
SPOKANE WASTEWATER STUDY
ZONES II AND III
SCALE-MILES
0
1/2
VI-2 A
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE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CENTRAL BUSINESS DISTRICT.
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
CAPACITY CFS
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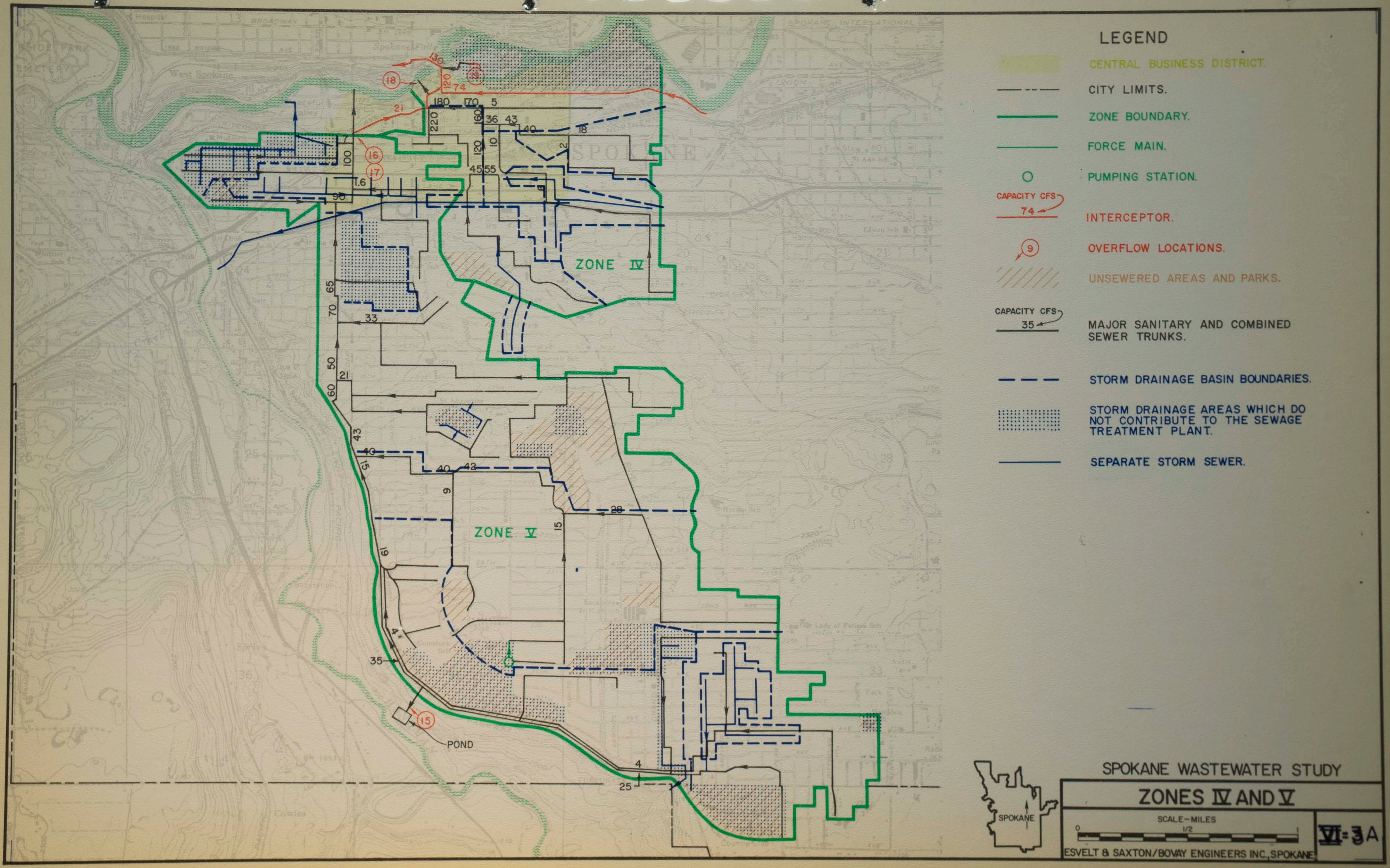
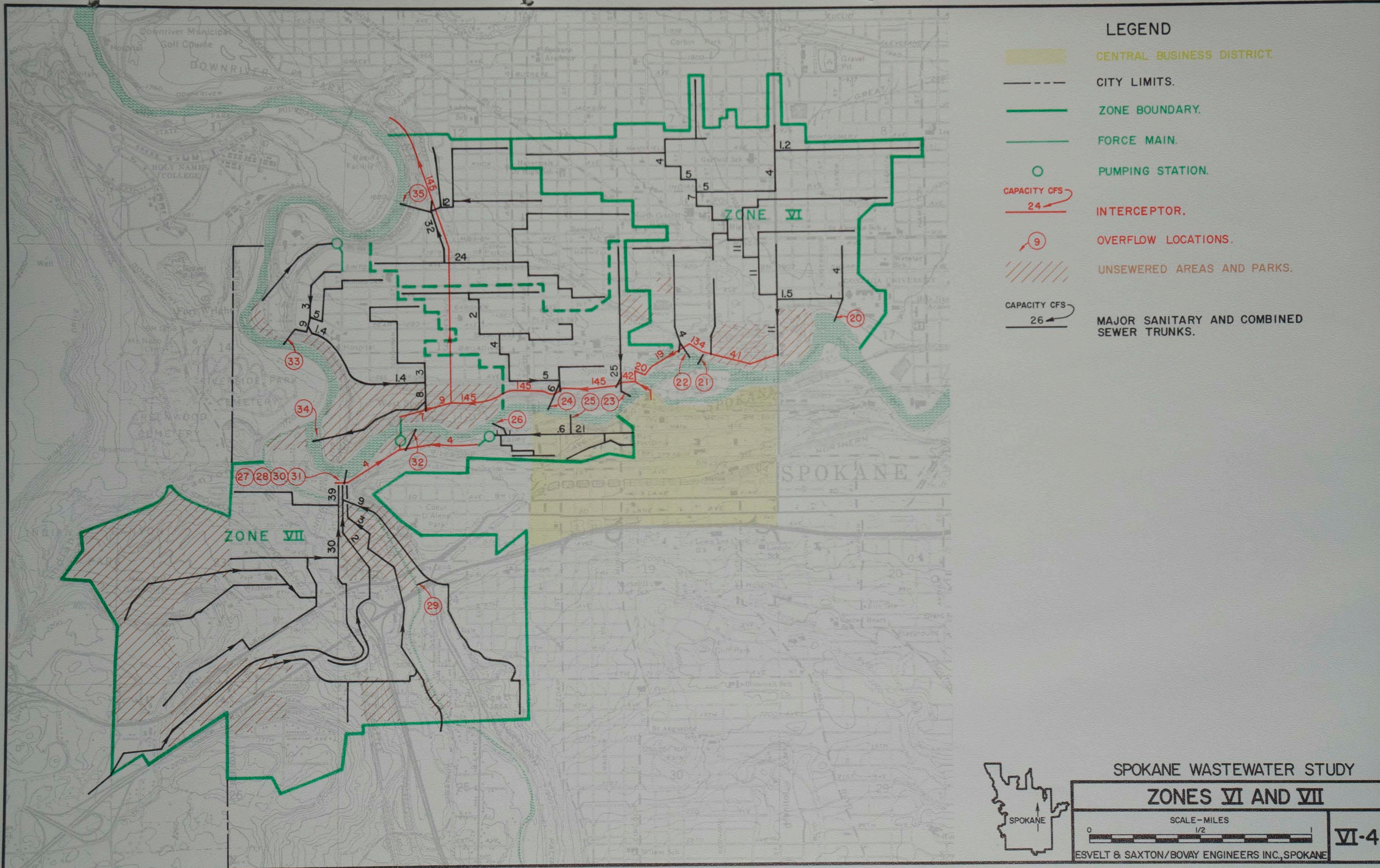
INTERCEPTOR.
9
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS
35
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
ZONE IV
ZONE V
POND
SPOKANE
SPOKANE WASTEWATER STUDY
ZONES IV AND V
SCALE-MILES
0
1/2
1
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
VI-3


LEGEND
CENTRAL BUSINESS DISTRICT.
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
CAPACITY CFS
74
INTERCEPTOR.
9
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS
35
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
STORM DRAINAGE BASIN BOUNDARIES.
STORM DRAINAGE AREAS WHICH DO NOT CONTRIBUTE TO THE SEWAGE TREATMENT PLANT.
SEPARATE STORM SEWER.
ZONE IV
ZONE V
POND
SPOKANE
SPOKANE WASTEWATER STUDY
ZONES IV AND V
SCALE-MILES
0
1/2
ESVELT & SAXTON/BOVAY ENGINEERS INC.,SPOKANE
VI-3A

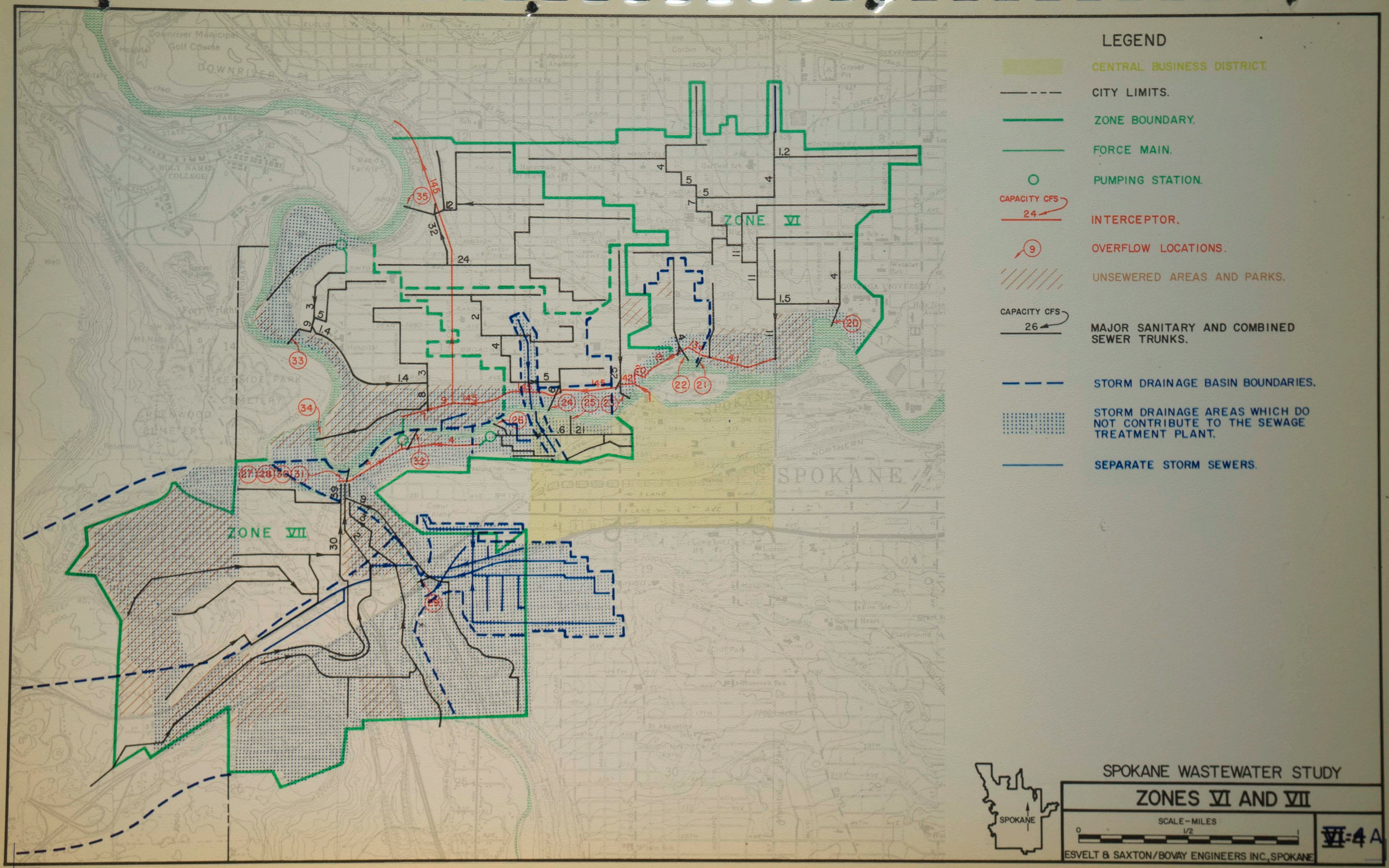


SPOKANE WASTEWATER STUDY

ZONES VI AND VII

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

VI-4

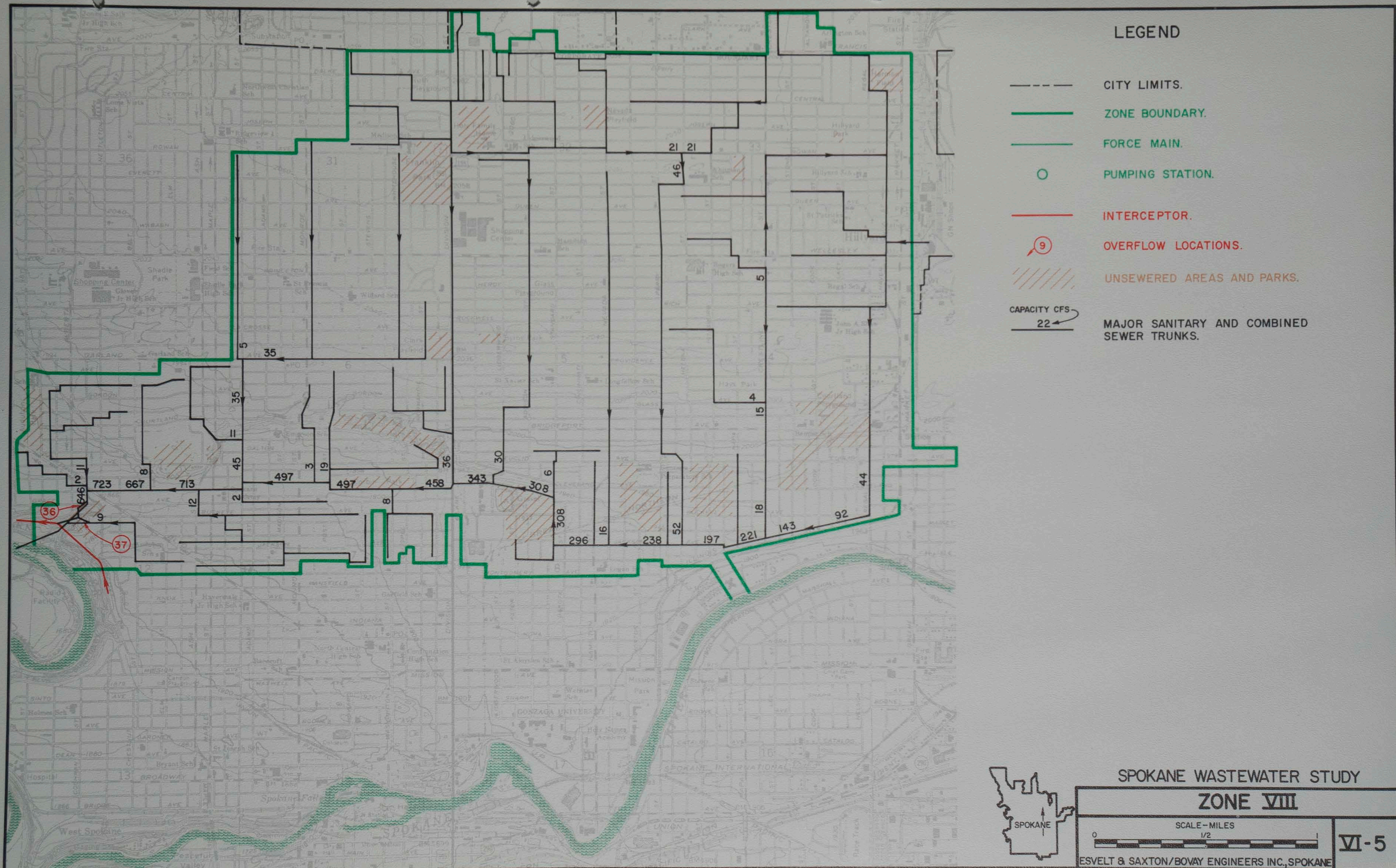


SPOKANE WASTEWATER STUDY

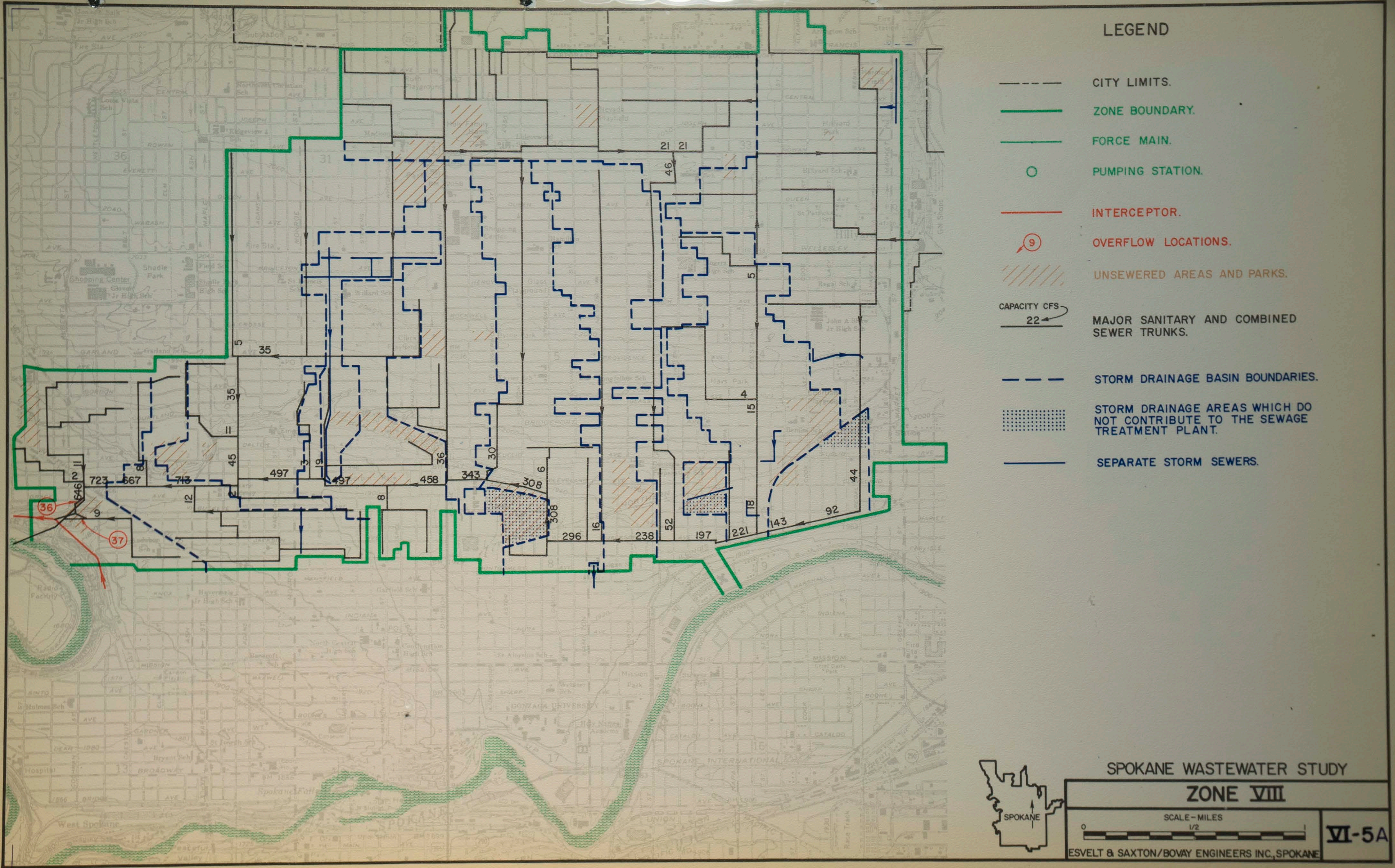
ZONES VI AND VII

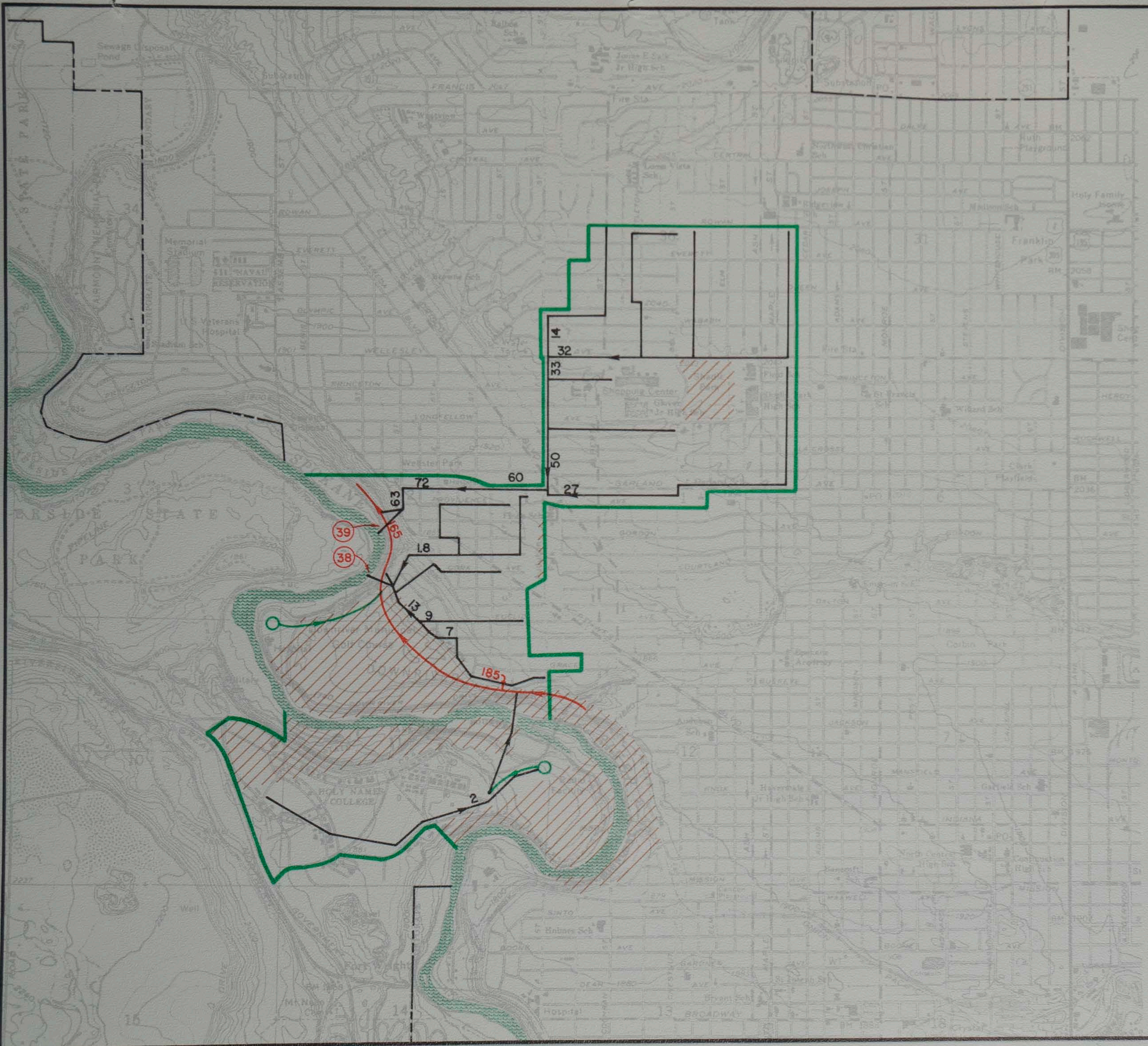
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

VI-4A



LEGEND
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
INTERCEPTOR.
9
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS
22
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
36
37
SPOKANE
SPOKANE WASTEWATER STUDY
ZONE VIII
SCALE–MILES
0
1/2
1
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
VI-5


LEGEND
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
INTERCEPTOR.
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS
22
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
STORM DRAINAGE BASIN BOUNDARIES.
STORM DRAINAGE AREAS WHICH DO NOT CONTRIBUTE TO THE SEWAGE TREATMENT PLANT.
SEPARATE STORM SEWERS.
SPOKANE
SPOKANE WASTEWATER STUDY
ZONE VIII
SCALE-MILES
0
1/2
1
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
VI-5A



LEGEND

CITY LIMITS.

ZONE BOUNDARY.

FORCE MAIN.

PUMPING STATION.

CAPACITY CFS 185 INTERCEPTOR.

9 OVERFLOW LOCATIONS.

UNSEWERED AREAS AND PARKS.

CAPACITY CFS 27 MAJOR SANITARY AND COMBINED SEWER TRUNKS.

SPOKANE

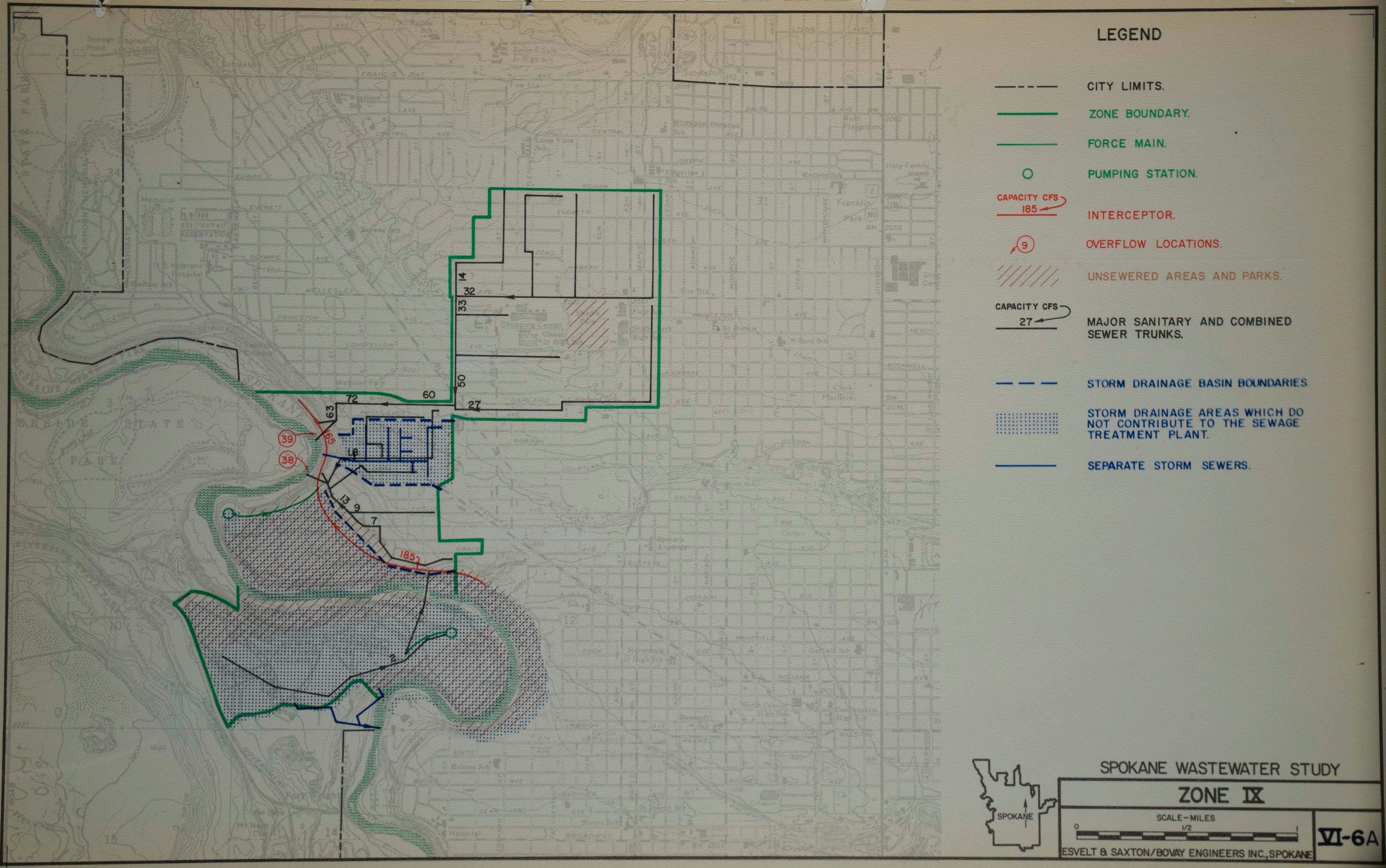
SPOKANE WASTEWATER STUDY

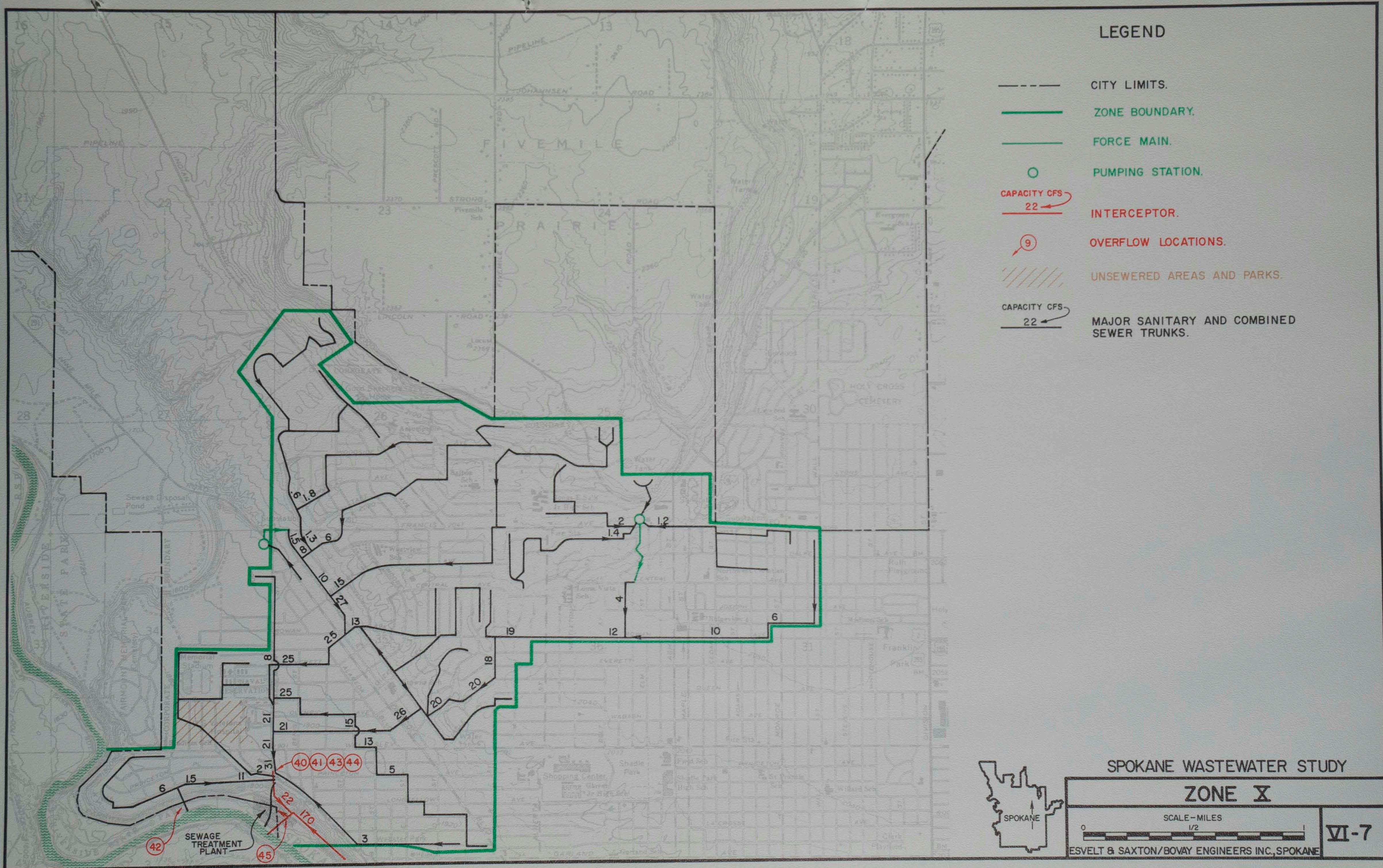
ZONE IX

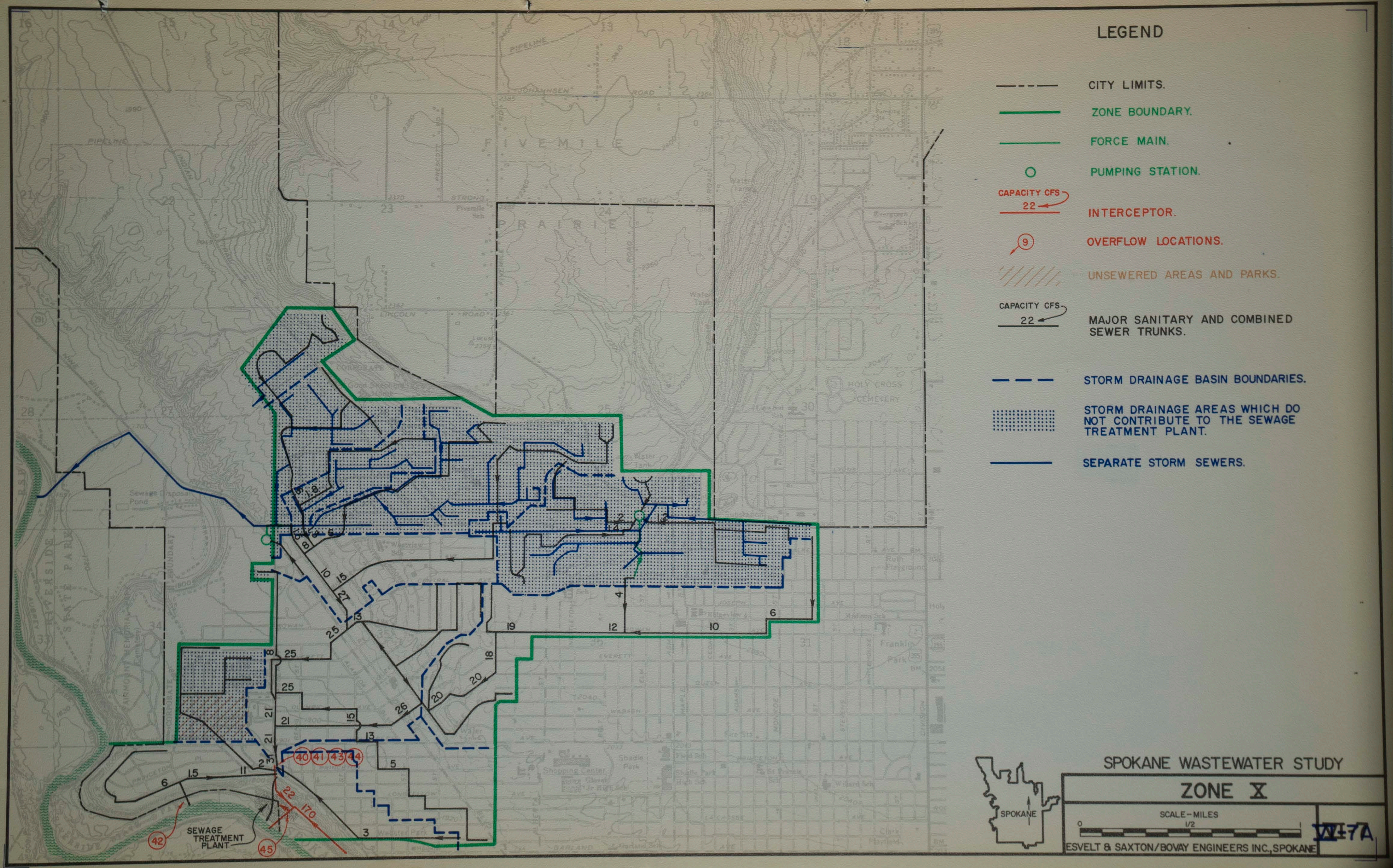
SCALE–MILES 0 1/2

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

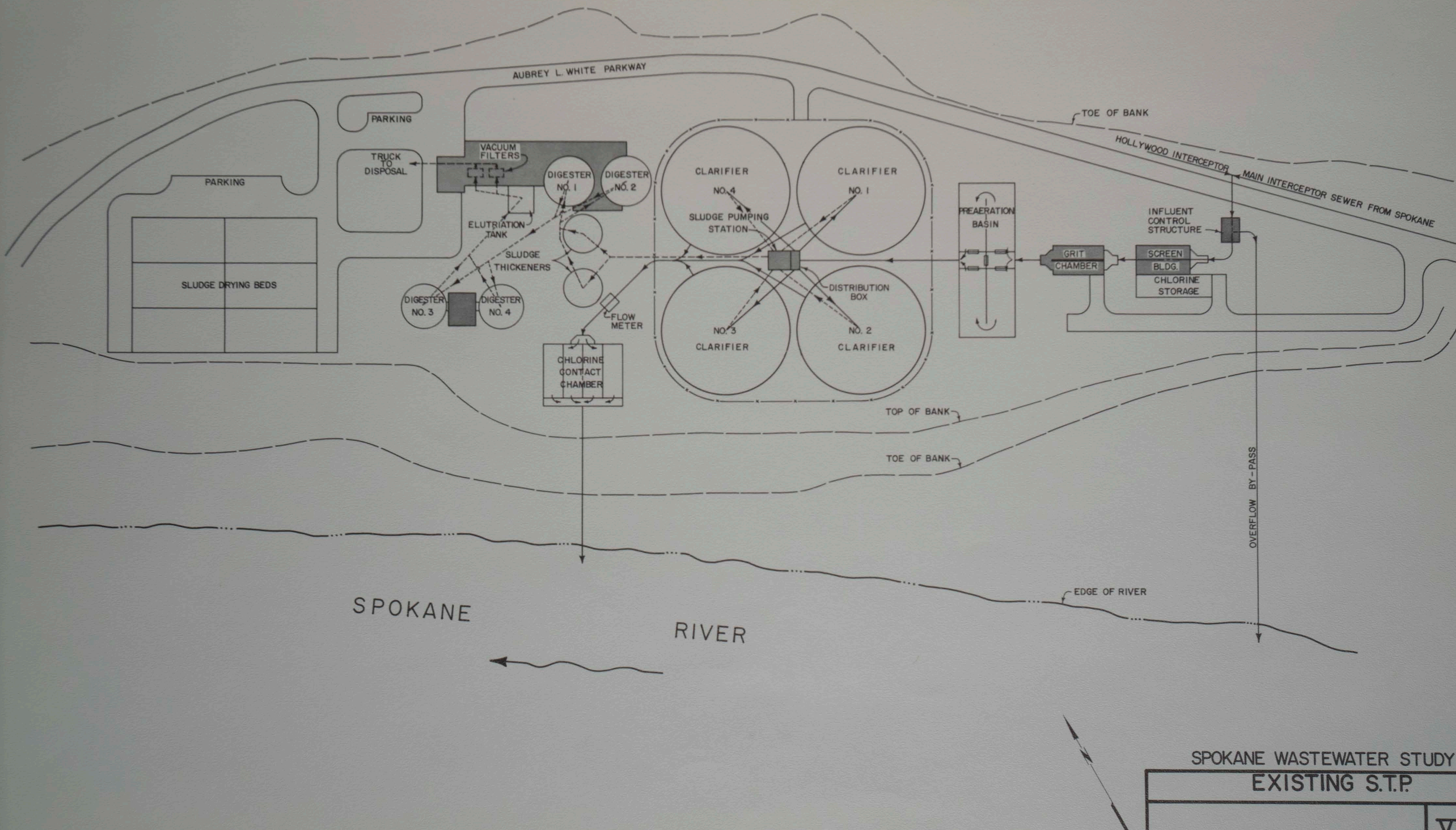
VI-6


LEGEND
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
CAPACITY CFS
185
INTERCEPTOR.
9
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS
27
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
STORM DRAINAGE BASIN BOUNDARIES.
STORM DRAINAGE AREAS WHICH DO NOT CONTRIBUTE TO THE SEWAGE TREATMENT PLANT.
SEPARATE STORM SEWERS.
SPOKANE
SPOKANE WASTEWATER STUDY
ZONE IX
SCALE-MILES
0
1/2
1
ESVELT & SAXTON/BOVAY ENGINEERS INC.,SPOKANE
VI-6A


LEGEND
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
CAPACITY CFS
22
INTERCEPTOR.
9
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS
22
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
FIVEMILE
PRAIRIE
SEWAGE TREATMENT PLANT
40 41 43 44
42
45
SPOKANE
SPOKANE WASTEWATER STUDY
ZONE X
SCALE-MILES
0
1/2
1
ESVELT & SAXTON/BOVAY ENGINEERS INC.,SPOKANE
VI-7



LEGEND
CITY LIMITS.
ZONE BOUNDARY.
FORCE MAIN.
PUMPING STATION.
CAPACITY CFS
22
INTERCEPTOR.
9
OVERFLOW LOCATIONS.
UNSEWERED AREAS AND PARKS.
CAPACITY CFS
22
MAJOR SANITARY AND COMBINED SEWER TRUNKS.
STORM DRAINAGE BASIN BOUNDARIES.
STORM DRAINAGE AREAS WHICH DO NOT CONTRIBUTE TO THE SEWAGE TREATMENT PLANT.
SEPARATE STORM SEWERS.
FIVEMILE
PRAIRIE
SEWAGE TREATMENT PLANT
SPOKANE
SPOKANE WASTEWATER STUDY
ZONE X
SCALE-MILES
0
1/2
1
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
VI-7A

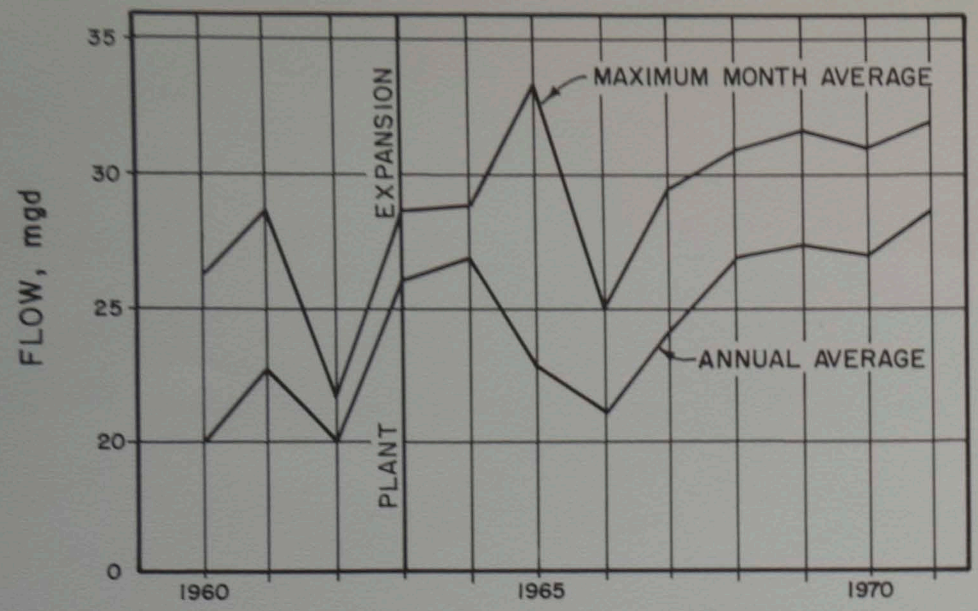


SPOKANE WASTEWATER STUDY

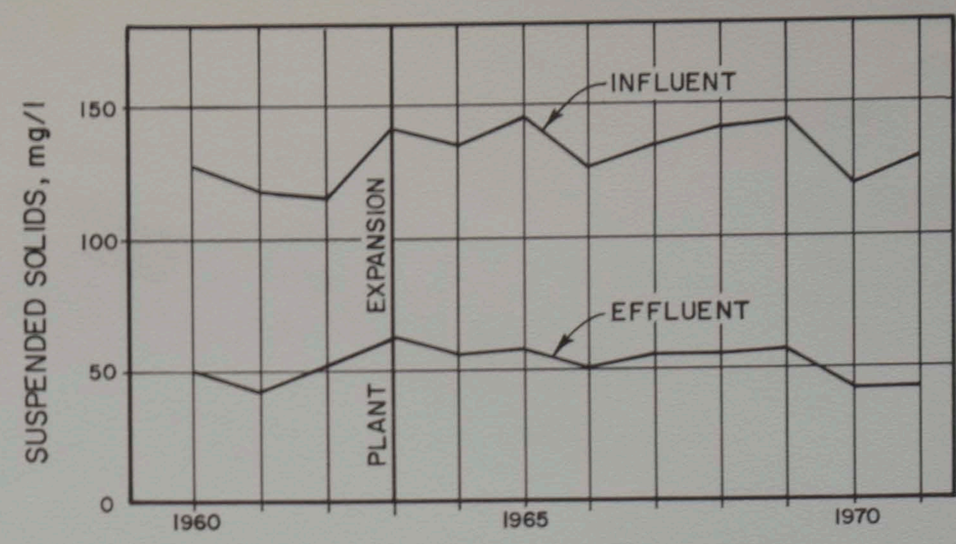
EXISTING S.T.P.

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

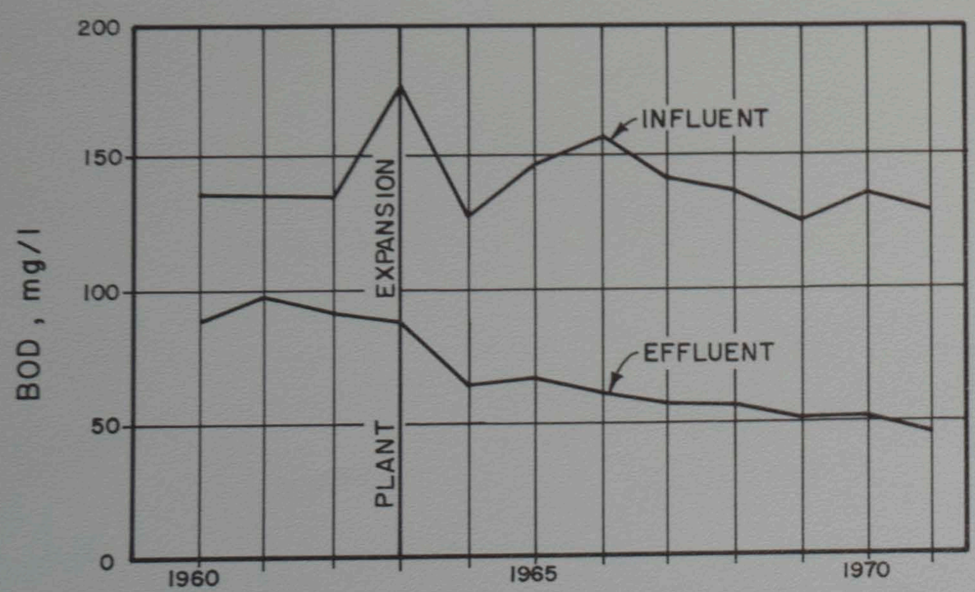
VI - 8



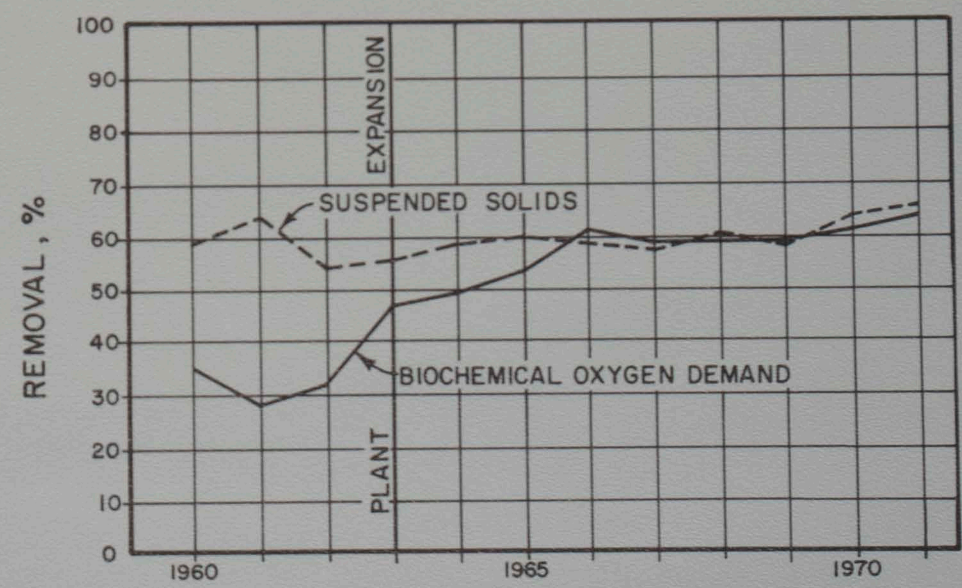
ANNUAL AVERAGE FLOW
FIGURE 1



SUSPENDED SOLIDS
FIGURE 2



BIOCHEMICAL OXYGEN DEMAND
FIGURE 3



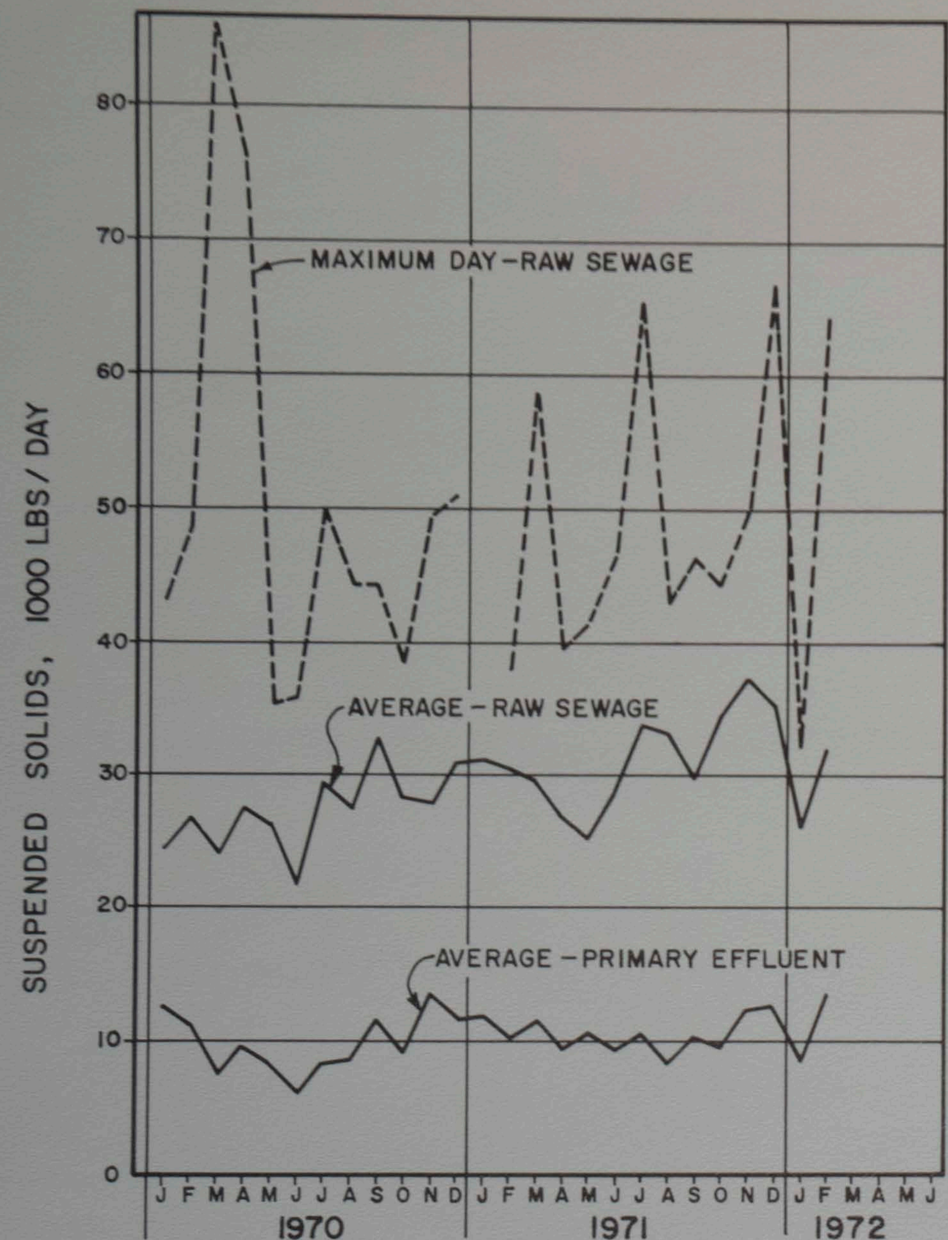
BOD AND SUSPENDED SOLIDS REMOVAL
FIGURE 4

SPOKANE WASTEWATER STUDY

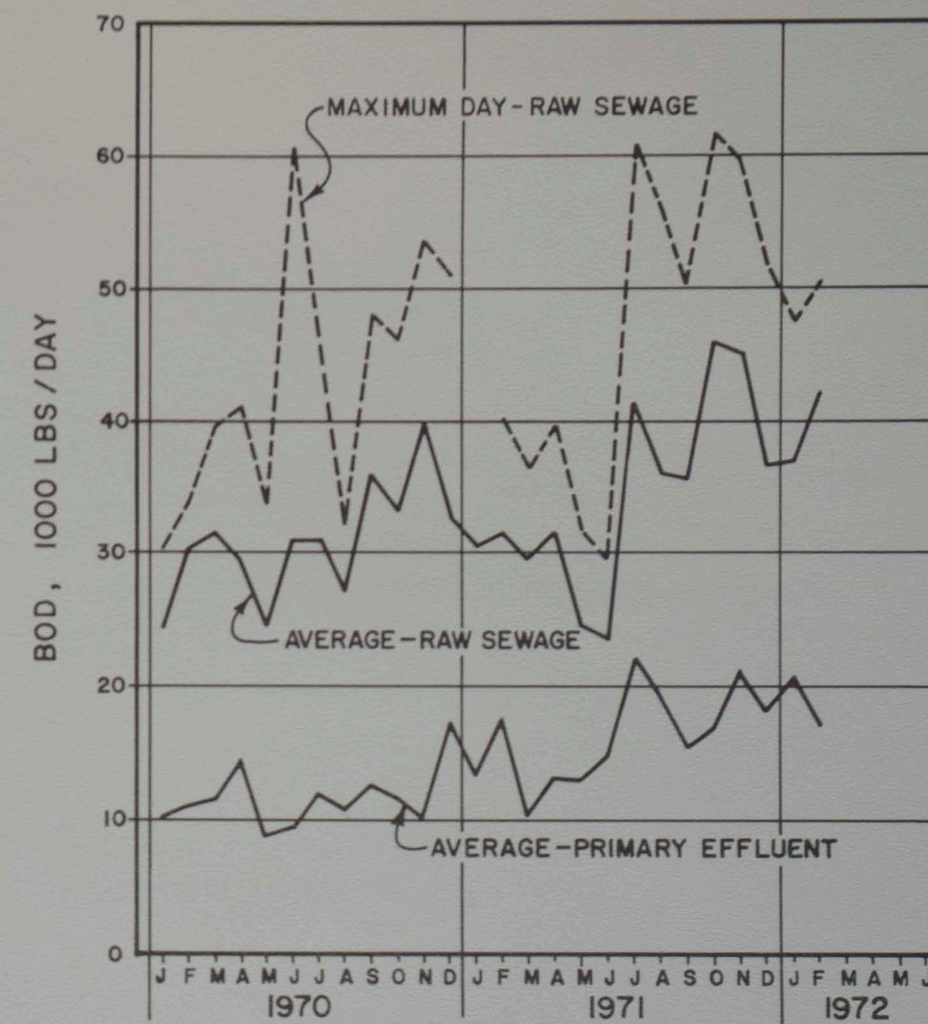
EXISTING STP PERFORMANCE

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

VI-9



SUSPENDED SOLIDS
FIGURE 8

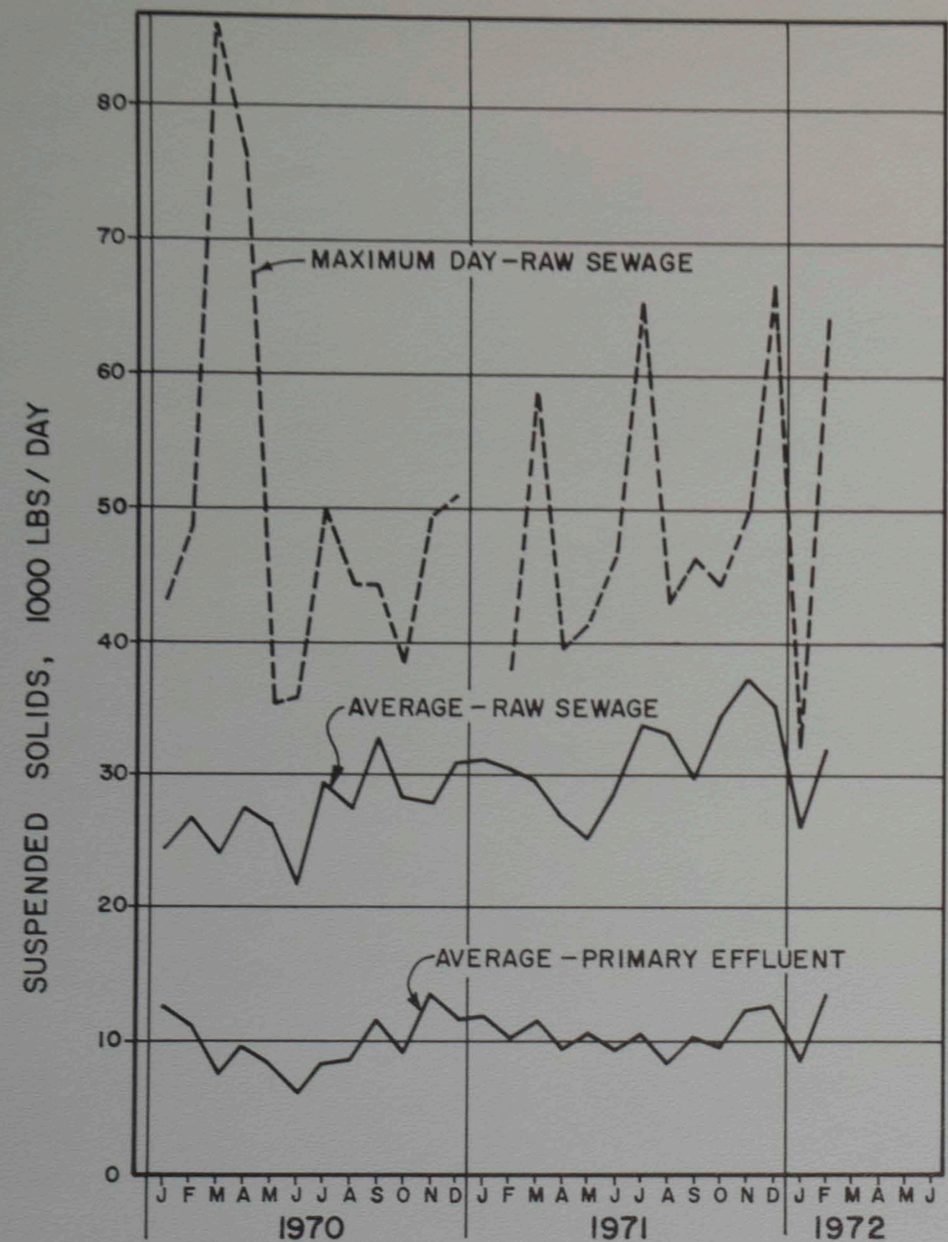


BIOCHEMICAL OXYGEN DEMAND (5-day)
FIGURE 9

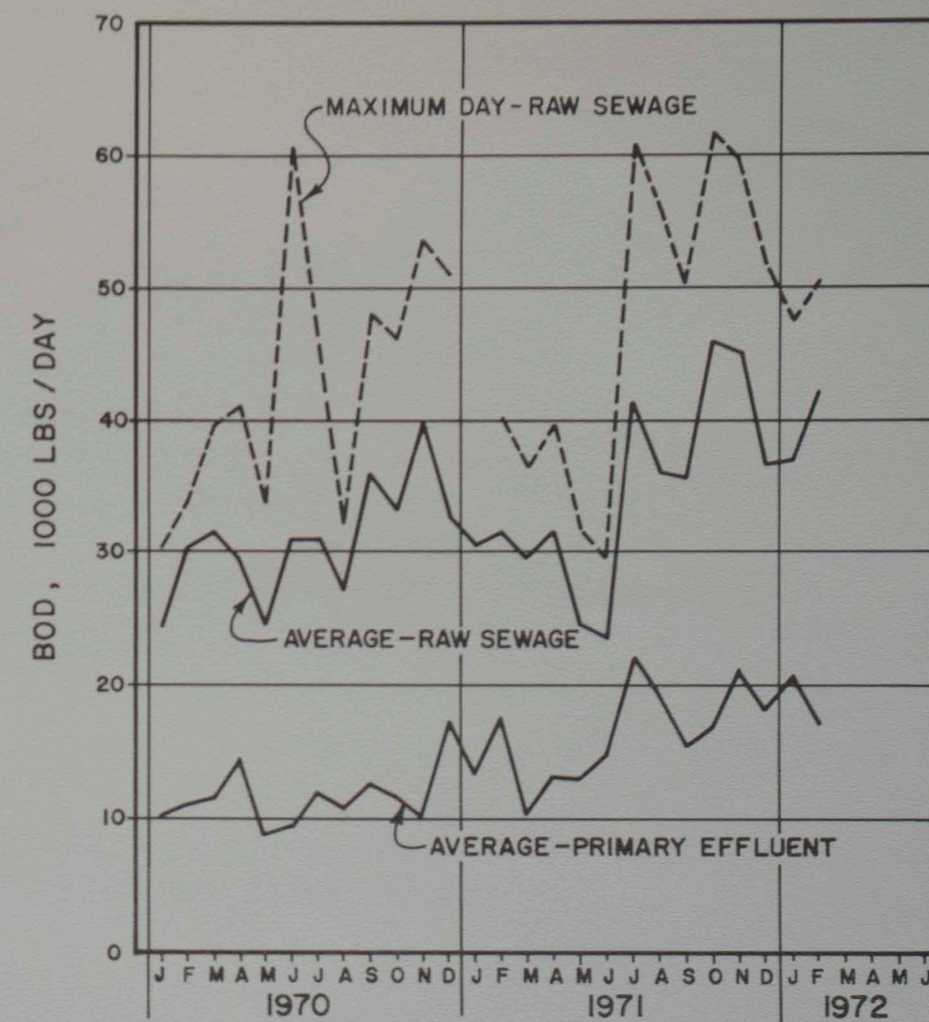
SPOKANE WASTEWATER STUDY

EXISTING STP PERFORMANCE

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE



SUSPENDED SOLIDS
FIGURE 8

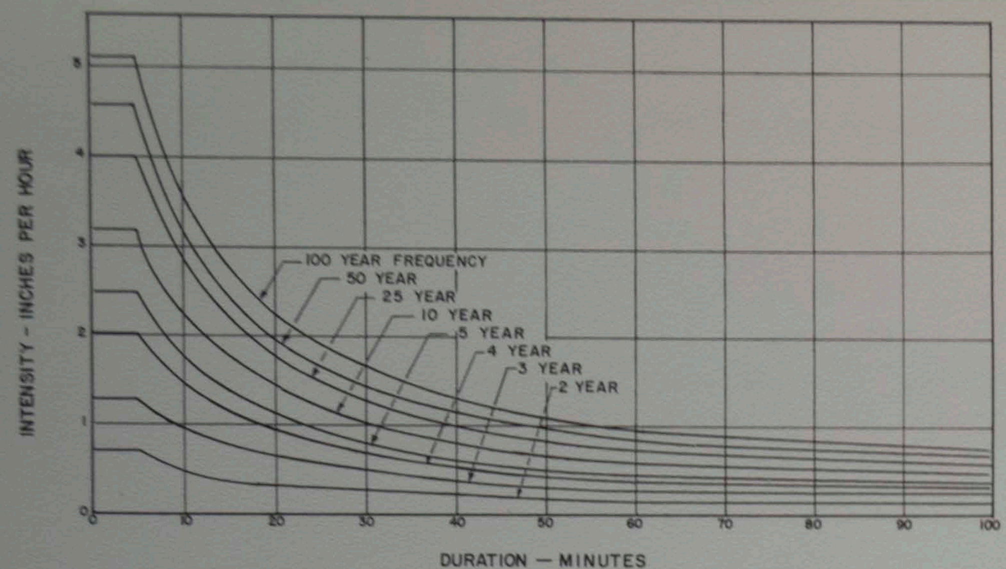


BIOCHEMICAL OXYGEN DEMAND (5-day)
FIGURE 9

SPOKANE WASTEWATER STUDY

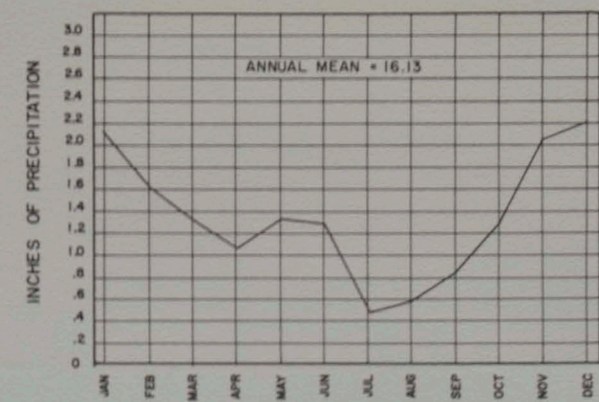
EXISTING STP PERFORMANCE

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE



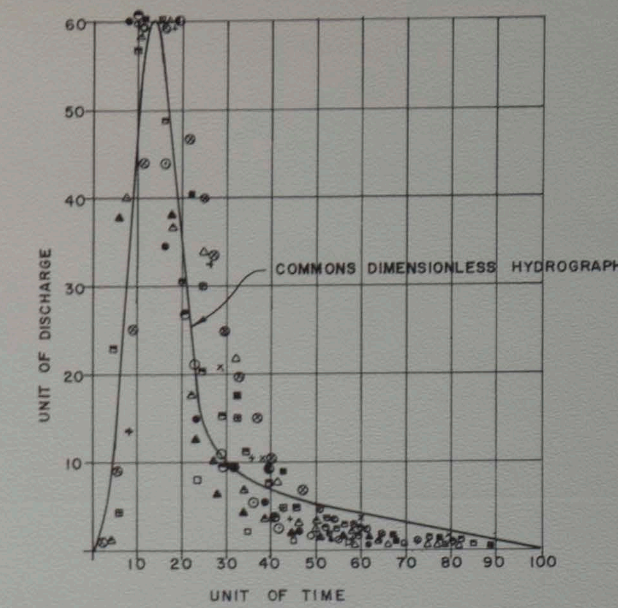
RAINFALL INTENSITY-DURATION-FREQUENCY
SPOKANE AREA

CURVES FROM WASHINGTON STATE HIGHWAY DEPT.
BASED ON U.S. WEATHER BUREAU DATA

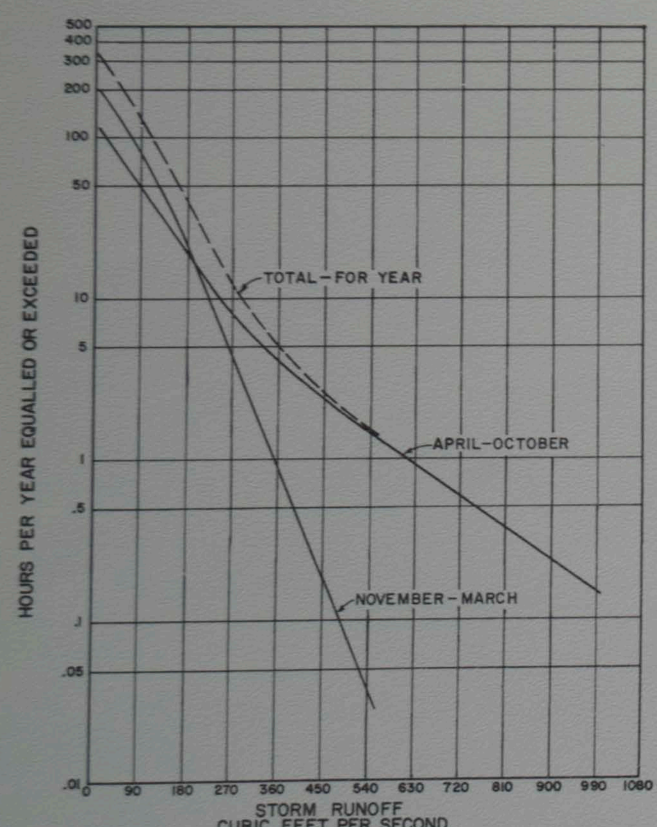


SPOKANE WASHINGTON
RECORDED MEAN MONTHLY PRECIPITATION
1882-1970

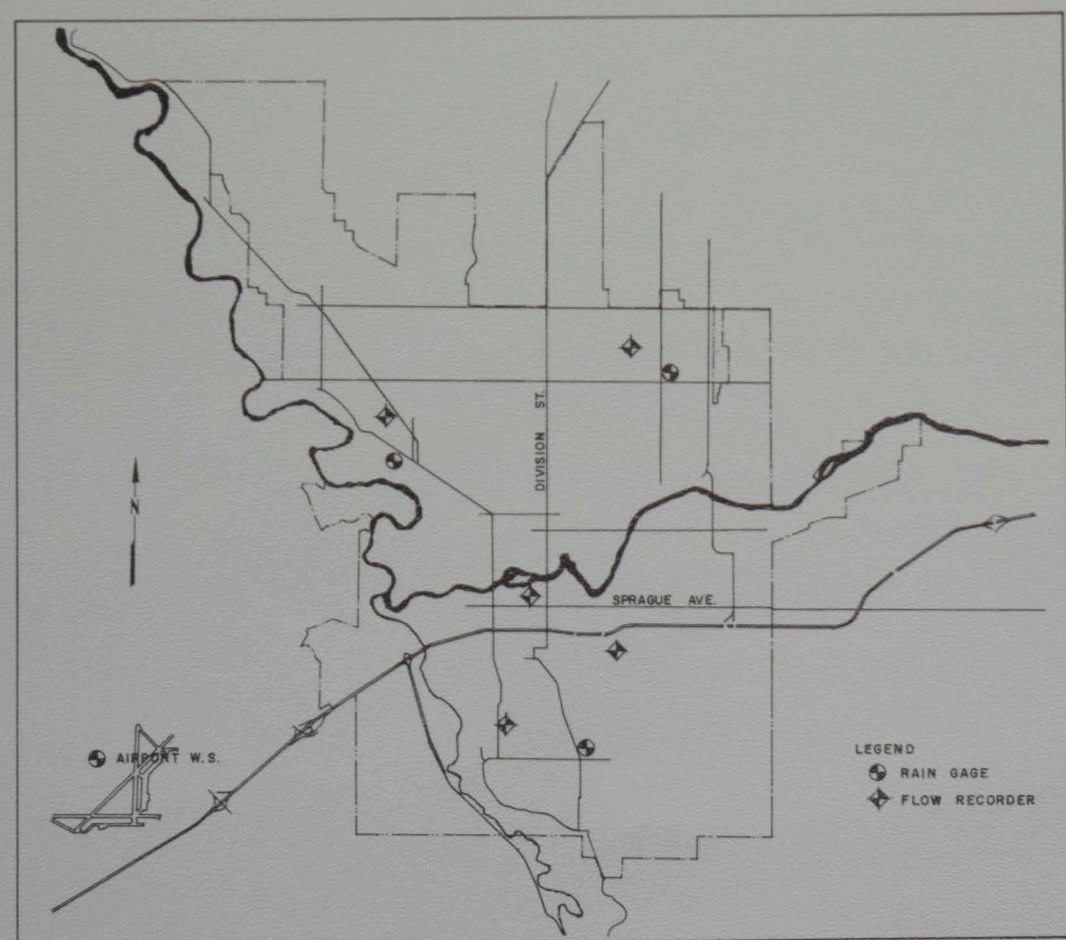
DATA FROM U.S. WEATHER BUREAU



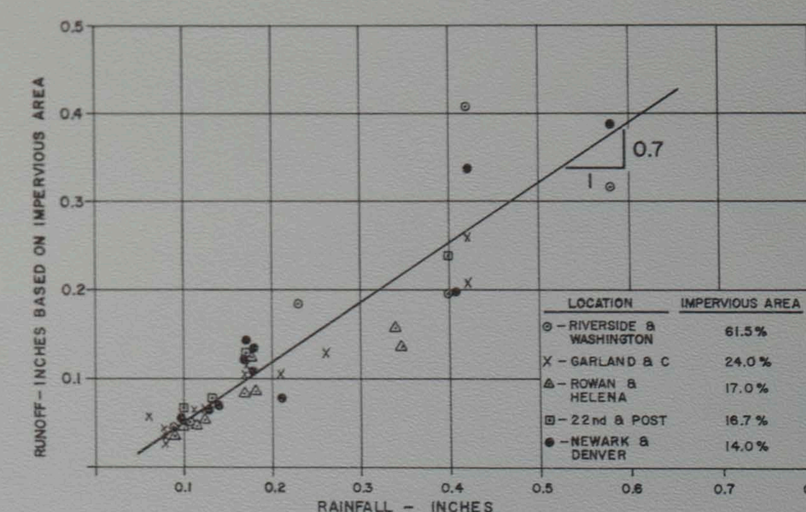
STUDY DATA ON
COMMONS UNIT HYDROGRAPH



STORM RUNOFF FREQUENCY



RAIN GAGE AND FLOW RECORDER LOCATIONS



RAINFALL-RUNOFF CORRELATION

SPOKANE WASTEWATER STUDY

RAINFALL-RUNOFF

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

VII - 1

INTERCEPTOR SYSTEM
EXISTING CONDITIONS, 5 YEAR STORM FLOW

OVERFLOW NO.	LOCATION OF TRUNKLINE INTERCEPTION	Existing Flows			Weir - At Present Setting						Capacity			Qsa Projected	
		Qsa	Qst	Qt	Type	De	Qw	R	Qo	Qa	Ct	Cc	Ci	1980	2000
	START - ZONE I														
	Surro @ S. Riverton	.03	--	.03	--	--	--	--	--	.03	3.79	--	3.79	.03	.03
1.	Surro @ S. Riverton	.25	5.99	6.24	DAM	7	2.85	.12/39	3.39	2.88	8.46	3.15	3.79	.24	.24
	Florida @ S. Riverton	.09	--	.09	--	--	--	--	--	3.06	3.06	--	3.06	.09	.09
	Freya @ S. Riverton	.09	--	.09	--	--	--	--	--	3.06	3.03	--	3.06	.15	.20
	Fiske @ S. Riverton	.24	--	.24	--	--	--	--	--	3.30	1.75	--	5.71	.24	.24
2.	Rebecca @ Upriver Dr.	.22	15.98	16.20	LW	5 1/2	1.60	.09/23	14.60	(1.60)	23.33	5.59	5.59	.23	.23
	Rebecca @ Upriver Dr.	.22	--	.22	--	--	--	--	--	(1.82)	5.59	--	5.59	.23	.23
	Regal @ Upriver Dr.	.49	--	.49	--	--	--	--	--	(2.31)	1.64	--	9.52	.51	.54
	Regal St. Siphon	--	--	2.31	--	--	--	--	--	5.61	9.52	--	16.85	--	--
3.	Regal @ S. Riverton	.15	4.54	4.69	LW	3	.28	.02/38	4.41	5.89	7.09	6.82	16.85	.16	.18
4.	Altamont @ S. Riverton	.13	5.40	5.53	LW	4 1/2	1.12	.16/31	4.41	7.01	5.59	6.55	16.85	.14	.15
5.	Magnolia @ S. Riverton	.20	8.17	8.37	LW	4 1/2	1.12	.06/32	7.25	8.13	8.84	6.67	23.96	.22	.23
6.	Sharp @ Perry	(.86)	8.71	9.57	LW	3 3/4	.36	-.03*	9.21	(.36)	13.32	2.98	2.98	.93	.89
7.	DeSmet @ B.N.R.R.	.12	--	.12	LW	14	.82	--	--	(.48)	4.24	.82	.82	.13	.12
	DeSmet Siphon	--	--	.48	--	--	--	--	--	8.61	2.56	--	23.96	--	--

COLUMN HEADINGS AND ABBREVIATIONS:

Qsa - Peak Sanitary flow - Peak factor: 1.5; GPCD: 120; "N" .0155
Qst - Peak Storm Flow (5 year storm)
Qt - Peak Combined flow (not to exceed Ct)
De - Existing weir setting in inches
Qw - Maximum flow passed to interceptor, or downstream trunk, by existing weir setting
R - Maximum rainfall of a duration equal to time of concentration which weir will pass (intensity in inches/hour divided by time of concentration)

Qo - Peak overflow rate, includes amount unable to enter interceptor due to surcharge
Qa - Accumulated flow in interceptor downstream from overflow (not to exceed Ci)
Ct - Capacity of trunkline at point of interception
Cc - Capacity of intercepting connection
Ci - Capacity of interceptor downstream from overflow
LW - Leaping weir
SOF - Side Overflow Weir

SP - Stop Plank
* - Weir will overflow at Peak Sanitary flow
DROP - No weir - flow drops from trunk sewer into connecting sewer
Bracketed numbers; i.e., ( ) do not add directly to interceptor

SPOKANE WASTEWATER STUDY

INTERCEPTOR FLOWS

ESVELT & SAXTON/BOVAY ENGINEERS INC, SPOKANE

VII-2A

OVERFLOW NO.	LOCATION OF TRUNKLINE INTERCEPTION	Existing Flows			Weir - At Present Setting						Capacity			Qsa Projected	
		Qsa	Qst	Qt	Type	De	Qw	R	Qo	Qa	Ct	Cc	Ci	1980	2000
8.	Mallon @ Perry	.60	14.57	15.17	LW	6	1.54	.03/51	13.63	10.15	19.05	6.44	37.41	.62	.65
	Force Main from Springfield Pump Sta.	--	--	--	--	--	--			--	--		37.41	.03	.03
	Trent @ Erie	.37	5.82	6.19	--	--	--			16.57	6.42		37.41	.36	.36
	END - ZONE I START - ZONE II														
9.	Front @ Erie End Zone II	5.08	93.00	98.08	DAM	21	25.98	.07/70	72.10	42.55	126.42	55.85	84.92	5.52	6.25
	START - ZONE III														
10.	Front @ Erie	.66	13.17	13.20	DROP	17 1/2	7.40	.16/82	5.80	(7.40)	13.20	7.40		.66	.66
11.	5th @ Arthur	(.19)	10.53	10.72	LW	15	1.01	.09/22	9.71	(1.01)	15.32	1.01	53.57	.17	.17
12.	3rd @ Perry	(2.85)	69.00	54.08	SOF	18	12.92	.05/39	41.16	(12.92)	54.08	25.11		2.87	3.00
13.	3rd @ Arthur	(.01)	13.00	6.36	LW	6	.57	.06/24	5.79	(13.49)	6.36	2.16		.01	.01
14.	Front @ Erie	3.11	16.00	19.11	SP	22	27.01	.50/53	--	76.96	50.23	120.44	84.92	3.14	3.27
	END - ZONE III START - ZONE V														
15.	High Drive to Latah Cr.	(1.25)	30.86	32.11	SOF	21	17.40	.27/100	14.71	(18.30)	35.94		18.76	1.54	1.62
16.	Cedar @ Riverside	6.56	70.00	76.56	LW	23 1/2	21.29	.02/129	55.27	(21.29)	120.94	21.29	21.29	7.13	7.36
17.	Cedar @ Riverside	.14	10.80	7.31	DAM	12	4.68	.41/26	7.31	(21.29)	7.31	8.84	21.29	.14	.14
	END - ZONE V START - ZONE IV														
18.	Lincoln @ Trent	14.94	122.00	136.94	DAM	18	38.15	.06/118	98.79	(38.15)	227.94	53.57		15.60	15.55
	Trent @ Post	--	--		--	--	--	--	--	115.11			120.10		
19.	Howard @ Havermale	1.84	--	1.84	DAM	11	2.12	--	--	(1.84)	2.12	2.27	3.85	1.84	1.84
	Post St. Bridge	--	--	--	--	--	--	--	--	116.95			128.25		
	END - ZONE IV START - ZONE VI														

SPOKANE WASTEWATER STUDY

INTERCEPTOR FLOWS

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

VII-2B

OVERFLOW NO.	LOCATION OF TRUNKLINE INTERCEPTION	Existing Flows			Weir - At Present Setting						Capacity			Qsa Projected	
		Qsa	Qst	Qt	Type	De	Qw	R	Qo	Qa	Ct	Cc	Ci	1980	2000
20.	Astor @ DeSmet	(.32)	2.19	2.51	DAM	5	.91	.12/37	1.60	(.91)	3.85	.91		.31	.31
21.	N. End Wash.St. Bridge	2.82	51.29	46.40	DAM	36	13.04	.05/84	33.36	(13.04)	46.40	13.04		2.77	2.77
22.	N. End Howard St. Bridge	.13	49.11	3.85	SOF	6	1.98	.03/16	1.87	(15.02)	3.85	4.99		.13	.13
	Zone VI Siphon	--	--	--	--	--	--	--	--	(15.02)		19.88			
	END - ZONE VI														
	Lincoln @ Bridge Total Zone I - VI	--	--	--	--	--	--	--	--	131.97			142.11		
	START - ZONE VII A														
23.	Monroe @ Bridge	.25	53.45	24.42	LW	8	3.49	.05/16	20.93	135.46	24.42	12.16	144.84	.25	.25
24.	Cedar @ Ide	.61	18.60	6.42	LW	7	2.49	.04/52	3.93	137.95	6.42	3.95	144.84	.54	.54
	END - ZONE VII A START - ZONE VII B														
25.	Cedar @ Main	(.25)	9.54	9.79	ADJ. DAM	2 1/2	.64	.07/10	9.15	(.64)	21.51	.64		.25	.25
26.	Main @ Oak	.29	--	.68	DAM	10	1.10		--	(.68)	1.04	1.28		.29	.29
27.	1st Ave @ A Street	.04	.11	.15	DAM	4	.32	.09/10	--	(.15)	.64	1.44		.04	.05
28.	A Street @ Linton	.62	35.14	35.52	LW	7 1/2	4.36	.10/17	31.25	(4.42)	35.52		4.42	.67	.74
29.	Freeway to Latah Cr.	(.60)	8.09	8.69	DAM	12	1.82	.13/29	6.87	(1.82)	8.84	7.40		.61	.62
30.	A Street @ Linton	1.58	8.23	6.03	LW	12	2.22	.14/10	6.03	(4.42)	26.86		4.42	2.27	2.84
31.	A Street @ Linton	.11	--	.11	LW	12	2.22	--	.11	(4.42)	9.42		4.42	.22	.32
32.	Clarke @ Linton	--	--	.68	DAM	7 1/2	2.43	--	--	(.68)	4.98	2.43			
	Force Main from Clarke Street Pump Sta.	--	--	--	--	--	--		--	(5.10)			6.67		
33.	Sherwood @ Summit	(.40)	6.41	6.81	LW	7 3/4	1.34	.08/41	5.47	(1.34)	9.43	1.34		.40	.40
34.	Nettleton @ Ohio	.89	13.62	8.44	LW	8	1.79	-.001/79	6.65	(1.79)	8.44	4.59		.89	.89
	Nettleton @ Ohio	--	--	--	--	--	--	--	--	(6.89)			9.52		
	Chestnut @ Ohio	--	--	--	--	--	--	--	--	144.84			144.84		

END - ZONE VII B
START - ZONE VIIC

SPOKANE WASTEWATER STUDY

INTERCEPTOR FLOWS

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

VII-2C

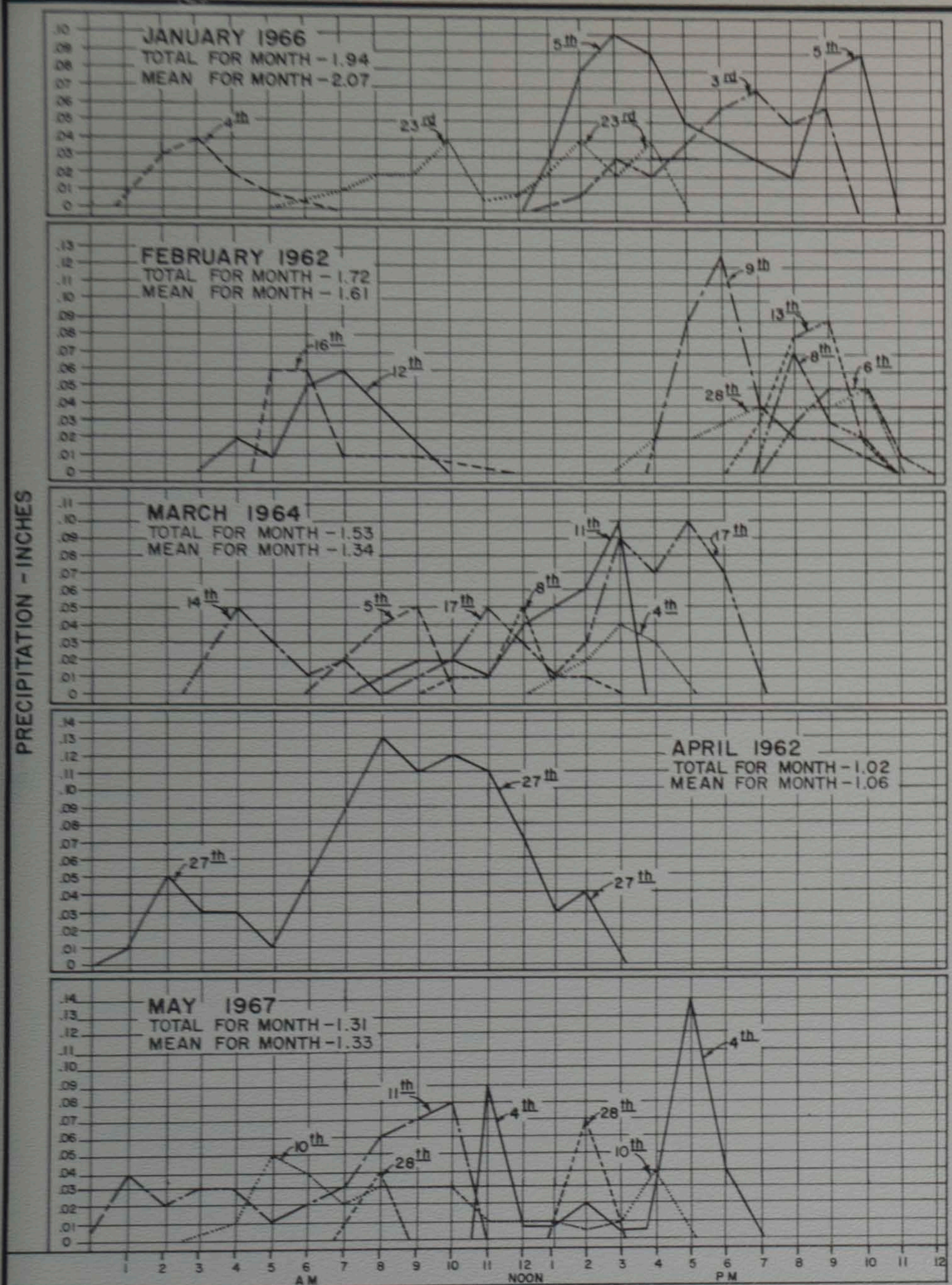
OVERFLOW NO.	LOCATION OF TRUNKLINE INTERCEPTION	Existing Flows			Weir - At Present Setting						Capacity			Qsa Projected	
		Qsa	Qst	Qt	Type	De	Qw	R	Qo	Qa	Ct	Cc	Ci	1980	2000
35.	Nora @ Pettet Dr.	1.31	28.67	29.98	LW	10	3.25	.03/31	26.73	144.84	39.54	4.74	144.84	1.23	1.23
	END - ZONE I - VII C START - ZONE VIII														
36.	Cochran @ Grace	(17.60)	182.00	199.60	DAM	9 5/8	15.90	-.002*	183.70	(15.90)	646.49	21.92		17.94	18.14
37.	Cochran @ Buckeye	.22	12.04	3.84	DAM	2 1/2	.34	.008/27	8.50	(16.24) 161.08	8.84	1.76	21.92 176.78	.22	.22
	END - ZONE VIII START - ZONE IX														
	Fort Wright College	.51	--	--	--	--	--	--	--	161.59			176.76	.57	.63
38.	Columbia Circle	.66	20.09	20.75	LW	6	1.20	.03/24	19.55	162.79	26.68	1.94	169.65	.66	.66
39.	Kiernan @ N. W. Blvd.	2.17	46.39	48.56	LW	17 1/2	8.73	.06/51	39.83	169.65	71.03	8.73	169.65	2.28	2.33
	END - ZONE IX START - ZONE X														
40.	N. W. Blvd. @ Assembly	(6.31)	61.56	30.76	LW	8	5.54	-.005*	25.22	(5.54)	30.76	63.17		7.27	7.75
41.	N. W. Blvd. @ Assembly	.03	--	.03	DAM	2	.14	--	--	(5.57)	2.20	9.15		.03	.03
42.	N. W. Blvd. @ Hartley	(.26)	8.84	9.10	LW	7 1/2	1.43	.09/37	7.67	(1.43)	14.75	1.43		.26	.26
43.	N. W. Blvd. @ Assembly	.31	3.99	5.47	LW	12	2.33	.20/43	3.14	(7.90)	10.74	40.52		.31	.31
44.	A. L. White @ Assembly (VAC)	--	--	7.90	DAM	21	20.36	--	--	(7.90)	47.13	21.21	21.21		
	END - ZONE X TOTAL TO S. T. P.	66.23	--	--	--	--	--	--	--	177.55			159.46	69.72	72.11

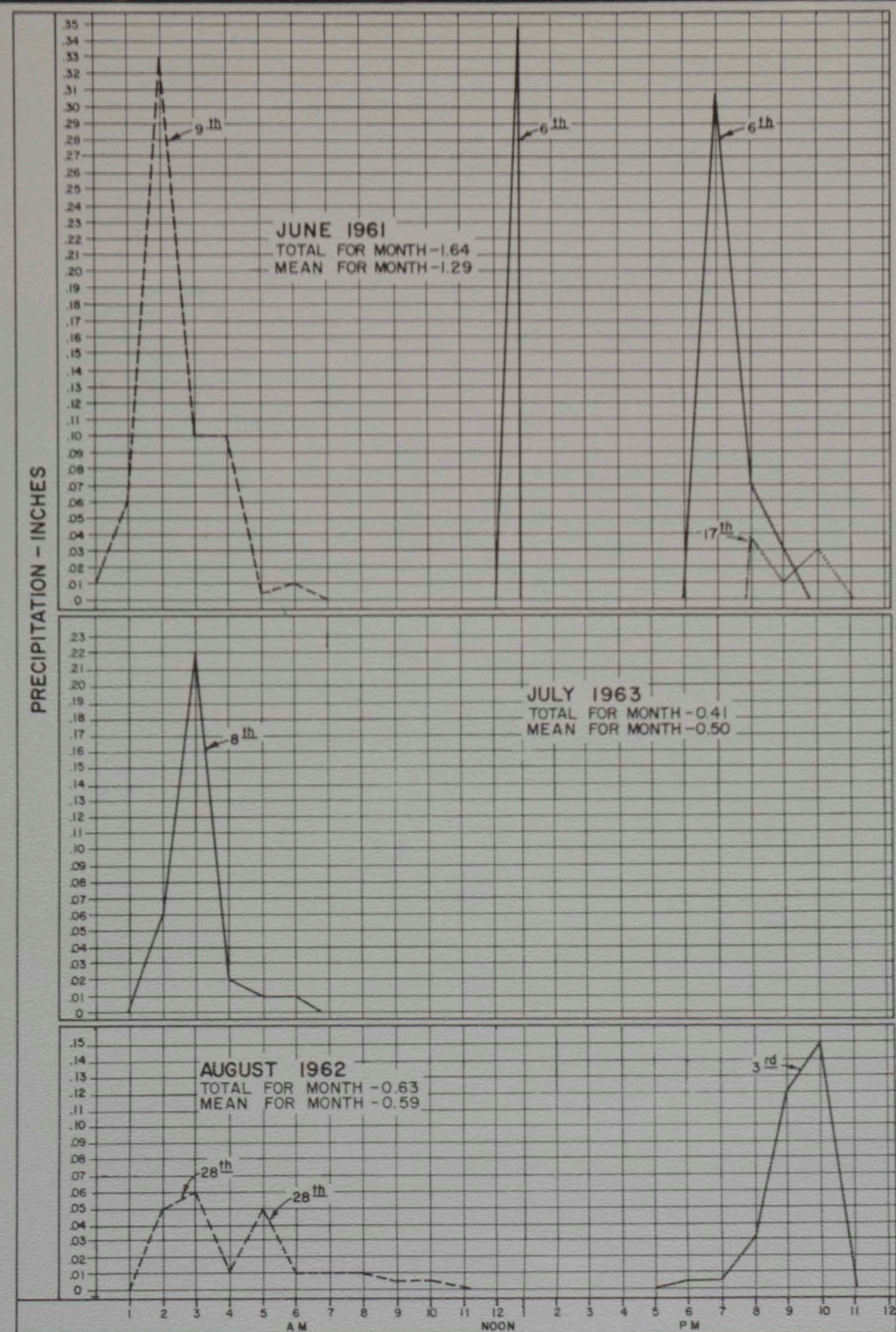
SPOKANE WASTEWATER STUDY

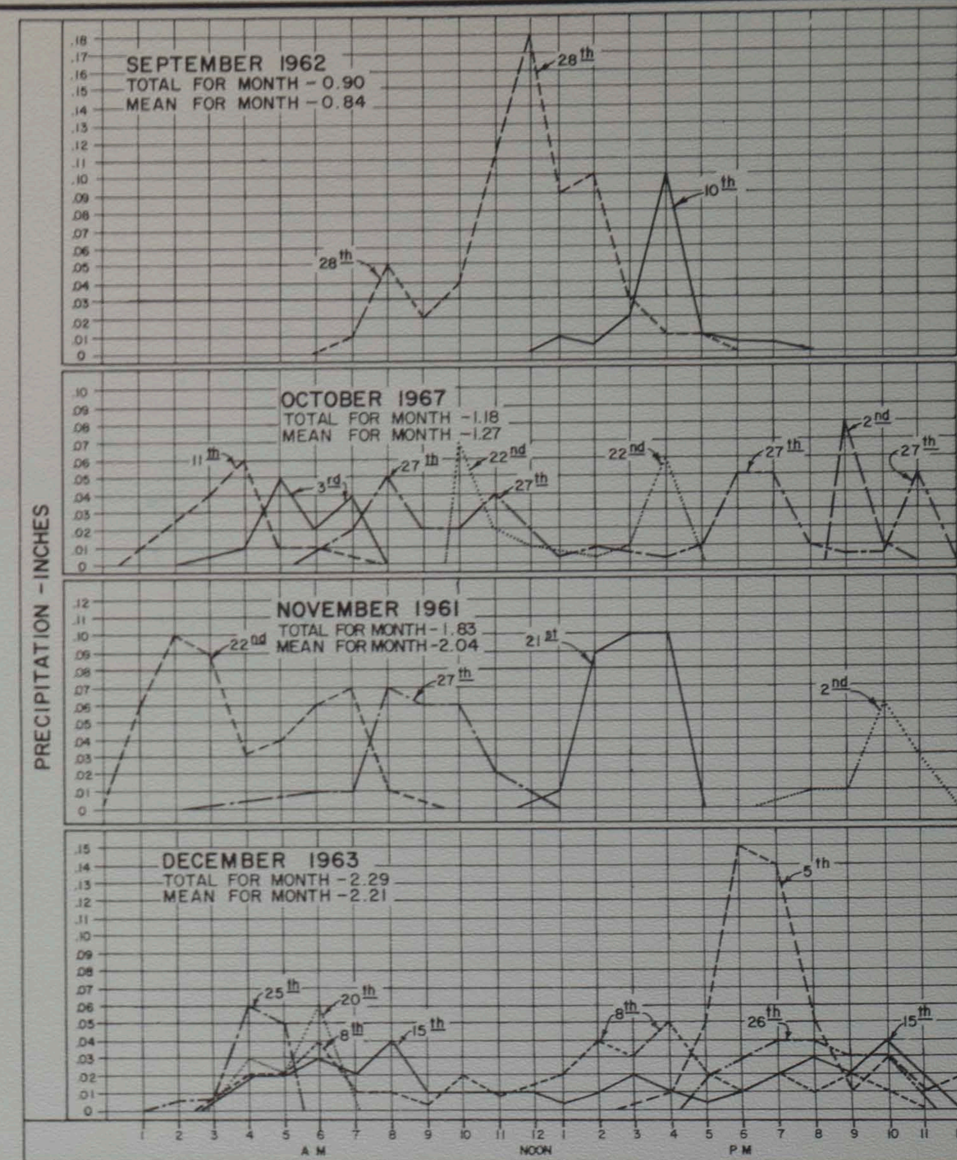
INTERCEPTOR FLOWS

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

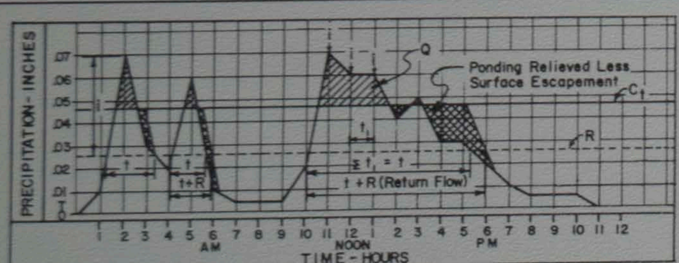
VII-2D







NOTE: STORMS WHICH PEAKED AT LESS THAN 0.03 INCH ARE NOT SHOWN



METHOD OF OVERFLOW CALCULATIONS

SINGLE PEAK OVERFLOWS COMPUTED BY METHOD OF TRIANGLES

Aci = PEAK RUNOFF IN CFS.

$\frac{Aci}{2}$ = AVERAGE RUNOFF IN CFS.

$\frac{Acit}{2}$ = VOLUME OF INDIVIDUAL OVERFLOW.

$\Sigma\frac{Acit}{2}$ = TOTAL VOLUME OF OVERFLOWS FOR MONTH (t IN SECONDS)

MASS OVERFLOWS COMPUTED BY METHOD OF END AREAS

$(\Sigma i)(t_i)$ = APPROXIMATE AREA OF MASS OVERFLOWS.

$(\Sigma i)Act_i$ = VOLUME OF INDIVIDUAL MASS OVERFLOWS (t_i IN SECONDS).

t = DURATION OF INDIVIDUAL OVERFLOW.

t_i = TIME INCREMENT.

A = CONTRIBUTING AREA IN ACRES.

c = COMPOSITE RUNOFF COEFFICIENT OF CONTRIBUTING ACRES.

i = RAINFALL IN EXCESS OF WIER CAPACITY (IN/HR).

R = POINT OF OVERFLOW.

C_t = TRUNK LINE CAPACITY.

Q = RETAINED BY PONDING.

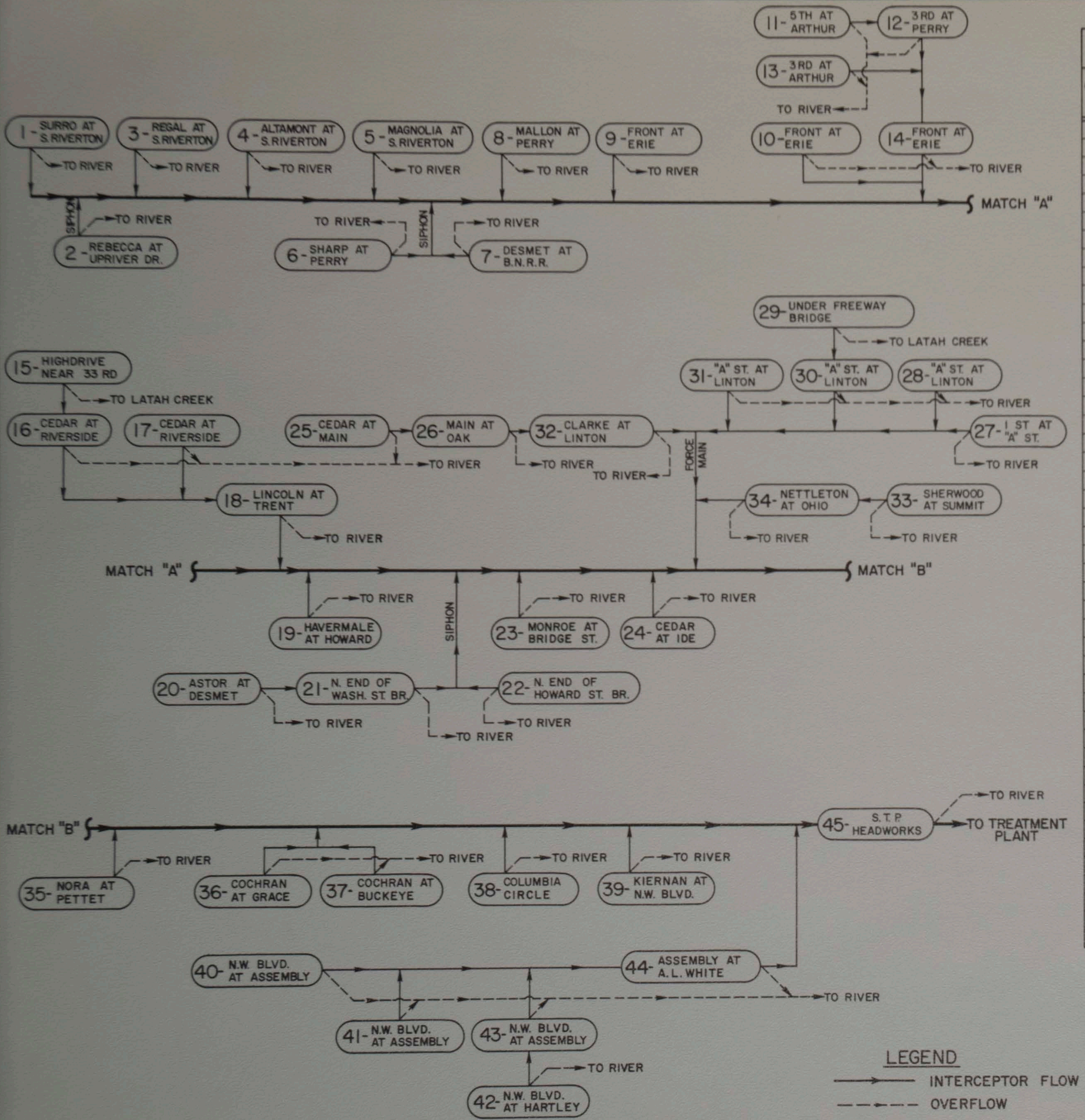
28th = DAY OF MONTH.

SPOKANE WASTEWATER STUDY

OVERFLOW CALCULATIONS

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

VII-3



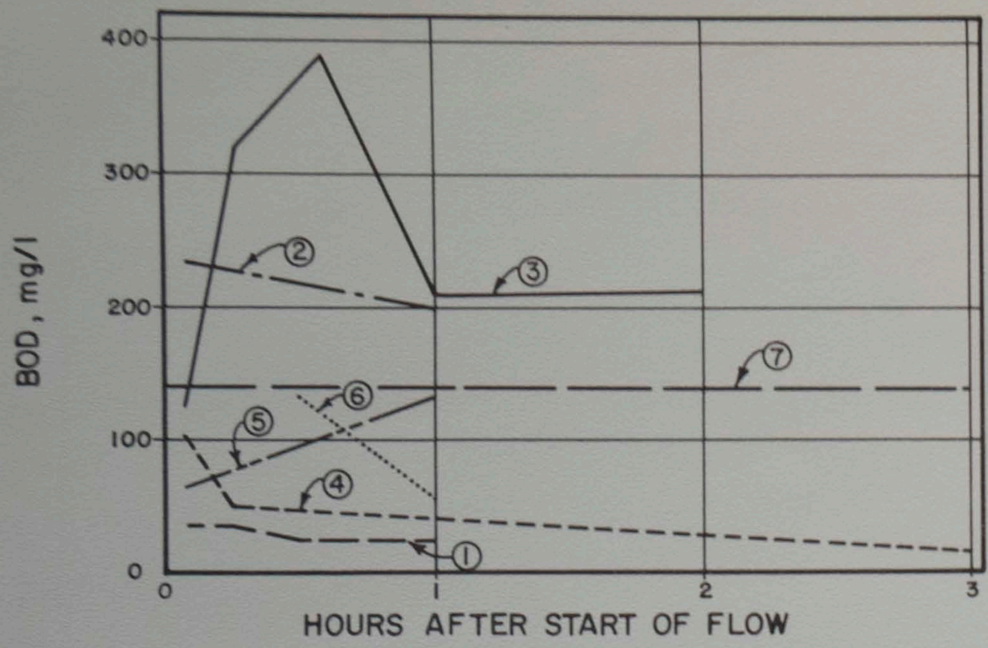
TABULATION OF EXISTING OVERFLOWS - AVERAGE YEAR

OVERFLOW POINT NO.	LOCATION	ACRES CONTRIBUTING STORM RUNOFF	PEAK FLOW RATE C.F.S.	AVERAGE DURATION PER O.F. HRS.	AVERAGE VOLUME PER O.F. M.G.	TOTAL VOLUME PER YEAR M.G.	NO. OF OVERFLOWS PER YEAR	REMARKS
1	SURRO AT S. RIVERTON	64	0.76	0.35	0.01	0.01	3	
2	REBECCA AT UPRIVER DR.	100	3.90	1.56	0.03	0.45	17	
3	REGAL AT S. RIVERTON	51	2.18	2.73	0.02	1.25	75	
4	ALTAMONT AT S. RIVERTON	49	1.21	0.83	0.01	0.05	5	
5	MAGNOLIA AT S. RIVERTON	60	2.70	1.56	0.02	0.31	17	
6	SHARP AT PERRY	121	6.89	9.50	0.28	13.30	47	
7	DESMET AT B.N. R.R.	0	0	0	0	0	0	Sanitary only
8	MALLON AT PERRY	187	8.97	3.15	0.09	0.43	59	
9	FRONT AT ERIE	1975	74.65	1.72	0.55	10.91	20	
10	FRONT AT ERIE	276	3.94	0.63	0.03	0.08	3	
11	5 TH AT ARTHUR	64	2.49	1.59	0.02	0.26	17	
12	3 RD AT PERRY	1170	41.16	1.98	0.39	10.53	27	
13	3 RD AT ARTHUR	38	2.75	1.98	0.02	0.61	27	
14	FRONT AT ERIE	112	0	0	0	0	0	Restricted flow
15	HIGHDRIVE NEAR 33 RD	529	11.90	0.61	0.07	0.30	4	
16	CEDAR AT RIVERSIDE	1537	35.96	1.80	0.39	8.90	23	
17	CEDAR AT RIVERSIDE	17	0	0	0	0	0	
18	LINCOLN AT TRENT	588	56.44	2.02	0.42	15.68	37	
19	HAVERMALE AT HOWARD	0	0	0	0	0	0	
20	ASTOR AT DESMET	34	1.17	1.08	0.01	0.08	10	
21	N. END OF WASH. ST. BR.	645	23.22	1.72	0.24	5.75	23	
22	N. END OF HOWARD ST. BR.	79	1.87	1.95	0.08	2.90	37	
23	MONROE AT BRIDGE ST.	86	10.44	1.72	0.08	1.53	20	
24	CEDAR AT IDE	181	3.93	1.95	0.08	2.97	37	
25	CEDAR AT MAIN	35	1.47	1.80	0.01	0.25	22	
26	MAIN AT OAK	0	0	0	0	0	0	Restricted flow
27	I ST AT "A" ST.	20	0.32	1.70	0.01	0.10	17	
28	"A" ST. AT LINTON	243	9.11	1.66	0.09	0.85	10	
29	UNDER FREEWAY BRIDGE	49	1.32	0.87	0.01	0.05	4	
30	"A" ST. AT LINTON	50	1.95	1.56	0.01	0.23	16	
31	"A" ST. AT LINTON	0	0	0	0	0	0	Sanitary only
32	CLARKE AT LINTON	0	0	0	0	0	0	Restricted flow
33	SHERWOOD AT SUMMIT	74	2.99	1.74	0.02	0.43	20	
34	NETTLETON AT OHIO	135	6.65	9.32	0.15	6.88	46	
35	NORA AT PETTET	394	18.91	2.12	0.12	8.26	69	
36	COCHRAN AT GRACE	5185	182.00	9.21	6.03	283.60	47	
37	COCHRAN AT BUCKEYE	86	4.51	4.84	0.07	4.42	66	
38	COLUMBIA CIRCLE	129	6.19	2.12	0.04	2.70	69	
39	KIERNAN AT NW. BLVD.	635	16.00	1.80	0.17	3.96	23	
40	NW. BLVD. AT ASSEMBLY	1140	25.22	9.40	1.24	58.46	47	
41	NW. BLVD. AT ASSEMBLY	0	0	0	0	0	0	Albi Stadium-San only
42	NW. BLVD. AT HARTLEY	84	1.35	1.57	0.02	0.37	17	
43	NW. BLVD. AT ASSEMBLY	17	0.63	0.62	0.01	0.02	4	
44	ASSEMBLY AT AUBREY L. WHITE	0	0	0	0	0	0	Restricted flow
45	S T P HEADWORKS	N/A	N/A	N/A	N/A	N/A	N/A	Manual Gate

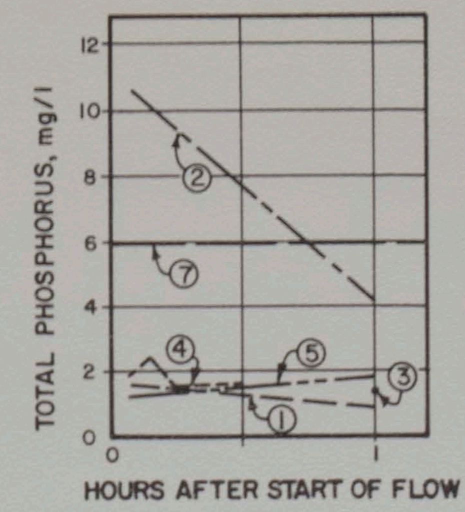
SPOKANE WASTEWATER STUDY

OVERFLOW TABULATION

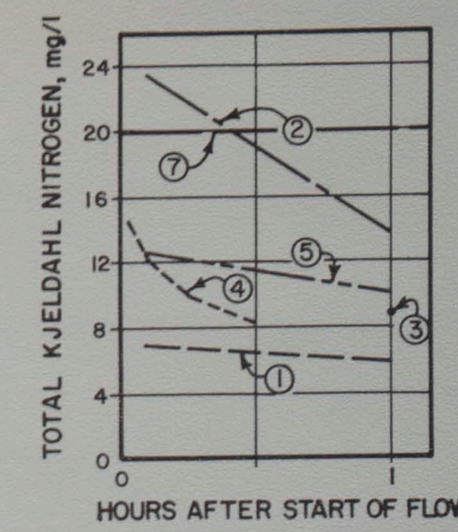
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE



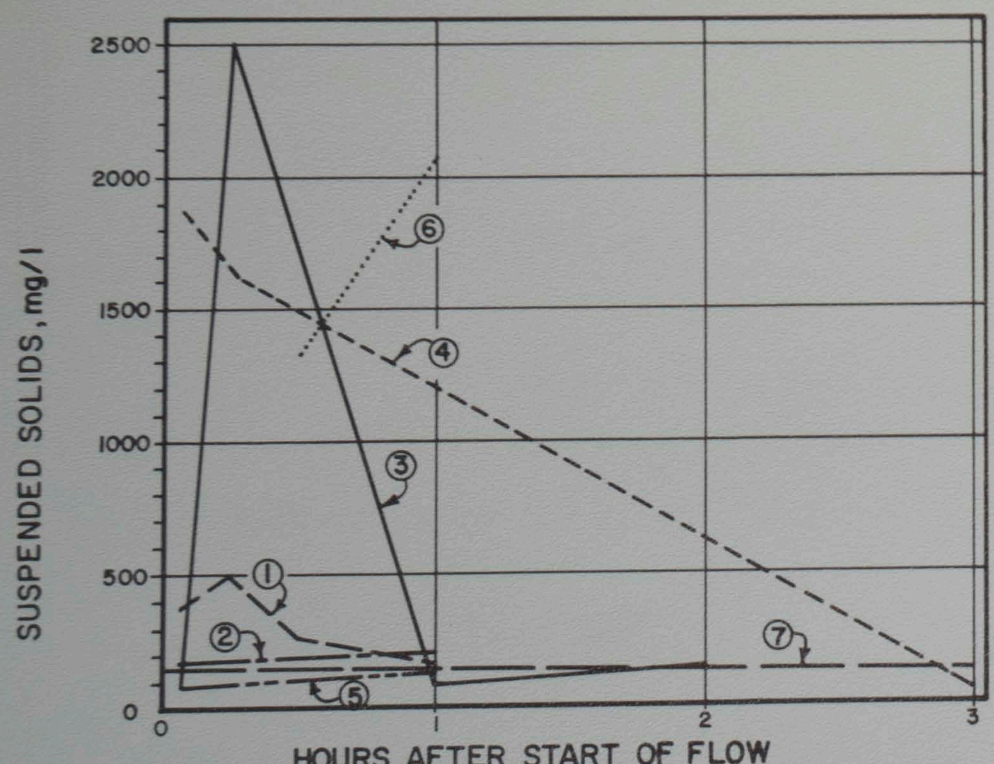
FLOW



PHOSPHORUS



KJELDAHL NITROGEN



SUSPENDED SOLIDS

LEGEND

1. Overflow at North end of Washington Street Bridge. No. 21 6-13-71
2. Overflow at Cochran and Grace. No. 36 6-18-71
3. Overflow at 7th and Inland Empire Highway. No. 29 8-22-71
4. Storm Flow at Superior and Cataldo. 8-30-71
5. Overflow at Lincoln and Trent. No. 18 6-10-71
6. Overflow at Erie Street. No. 9-14 8-30-71
7. Quality of Average Sanitary Sewage Flow

SPOKANE WASTEWATER STUDY

OVERFLOW QUALITY

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

IX-1

RUNOFF AND COMBINED QUALITY—VARIOUS STUDIES

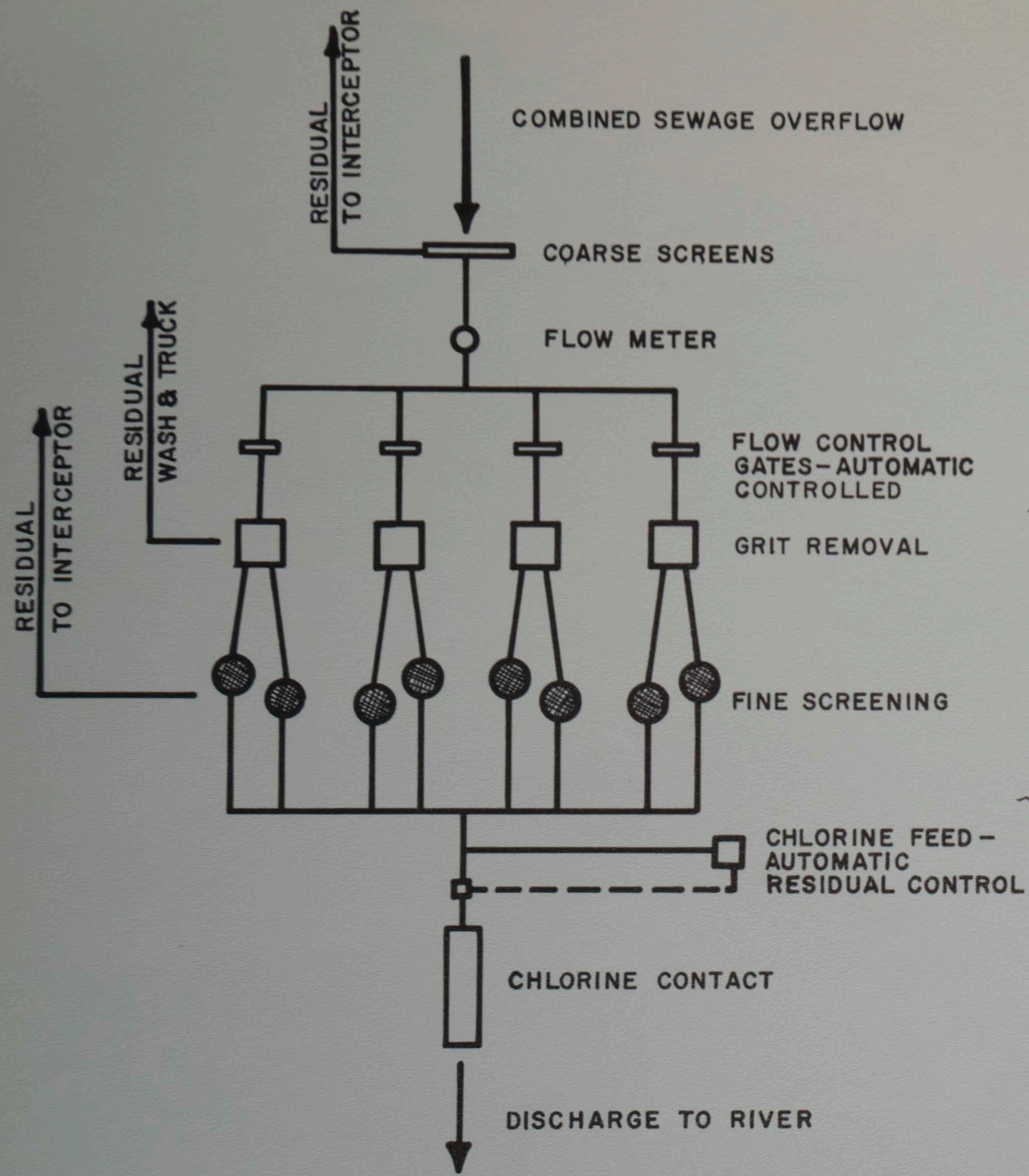
NO.	TYPE FLOW LOCATION	BOD			COD			SS			VSS			TKN			TOTAL P			MPN COLIFORM/100 ml		HEM (Grease)			COMMENTS	REF.
		AVE.	MAX.	MIN.	AVE.	MAX.	MIN.	AVE.	MAX.	MIN.	AVE.	MAX.	MIN.	AVE.	MAX.	MIN.	AVE.	MAX.	MIN.	MAX.	MIN.	AVE.	MAX.	MIN.		
1.	Runoff - Detroit	12	38	1	58	405	12	367	2,052	84	92	296	24	0.85	5.32	0	0.38	4.8	0						Several storms for each of 15 separate areas	9-2
2.	Runoff - Washington, D.C.		17	3		430	29		11,200	480		880	50		4.0	1.2		4.5	0.4						July 28 storm	9-3
3.	Runoff - Washington, D.C.		40	12		400	54		9,600	200		520	0		4.0	0.6		2.0	0.2						August 2 storm	9-3
4.	Runoff - Washington, D.C.		28	16		390	150		11,300	100		720	10		1.6	0.3		1.4	0.6						August 9 storm	9-3
5.	Runoff - Cincinatti	19	84	2	99	610	20	210	1,200	5	53	290	1	2.3	6.7	0.3	0.26	1.4	0.02	460,000	2,900				27 acre drainage - one year's record	9-5
6.	Runoff - East Bay M.U.D.	87	7,700	3				613	4,400	16										$7X10^4$	4					9-4
7.	Runoff - L.A. County	161																								9-4
8.	Runoff - Washington, D.C.	126	625	6				2,100	36,250	26															Catch basin samples	9-4
9.	Runoff - Seattle	10																		16,100 Ave.						9-4
10.	Runoff - Detroit		234	96					213	102										$9.3X10^5$						9-4
11.	Runoff - Stockholm		80	17		3,100	18													$2X10^5$	40					9-4
12.	Runoff - Moscow, U.S.S.R.		285						3,500																	9-4
13.	Combined Sewage - Bowling Green		1,410	102		7,400			4,700	163		1,700	130												June 19, 1968 storm	9-6
14.	Combined Sewage Overflow - Philadelphia	98	740	5				181	498	21	48	111	9							Fecal Coliform 28,000	5				Average during 29 storms, 1969	9-7
15.	Combined Sewage - San Francisco	49	202	1.5	155	626	17	68	426	4	52	373	4							$1.6X10^7$	$2.3X10^4$	12.3	54.4	1.3	50 samples during 10 storms - 1970	9-8
16.	First Flush Combined Sewage Overflows - Milwaukie, Wisconsin		182	170		765	500		848	330		495	221		24	17									30 overflows, 95 percentile range	9-9
17.	Extended Combined Sewer Overflows - Milwaukie		53	26		182	170		174	113		87	58		6	3				$3.1X10^5$	$1.5X10^3$				30 overflows, 95 percentile range	9-9

SPOKANE WASTEWATER STUDY

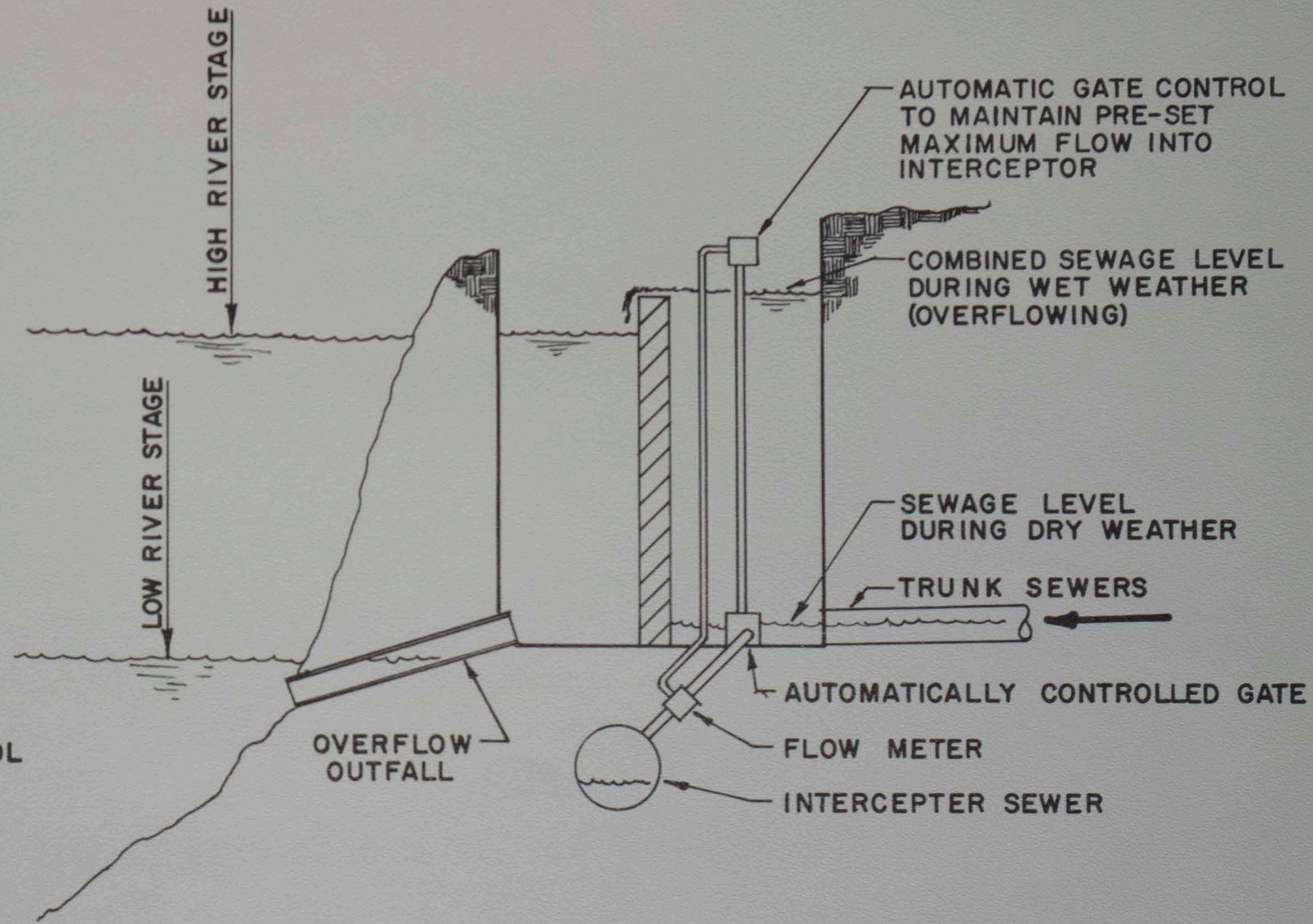
COMPARATIVE RUNOFF QUALITY

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

IX-2



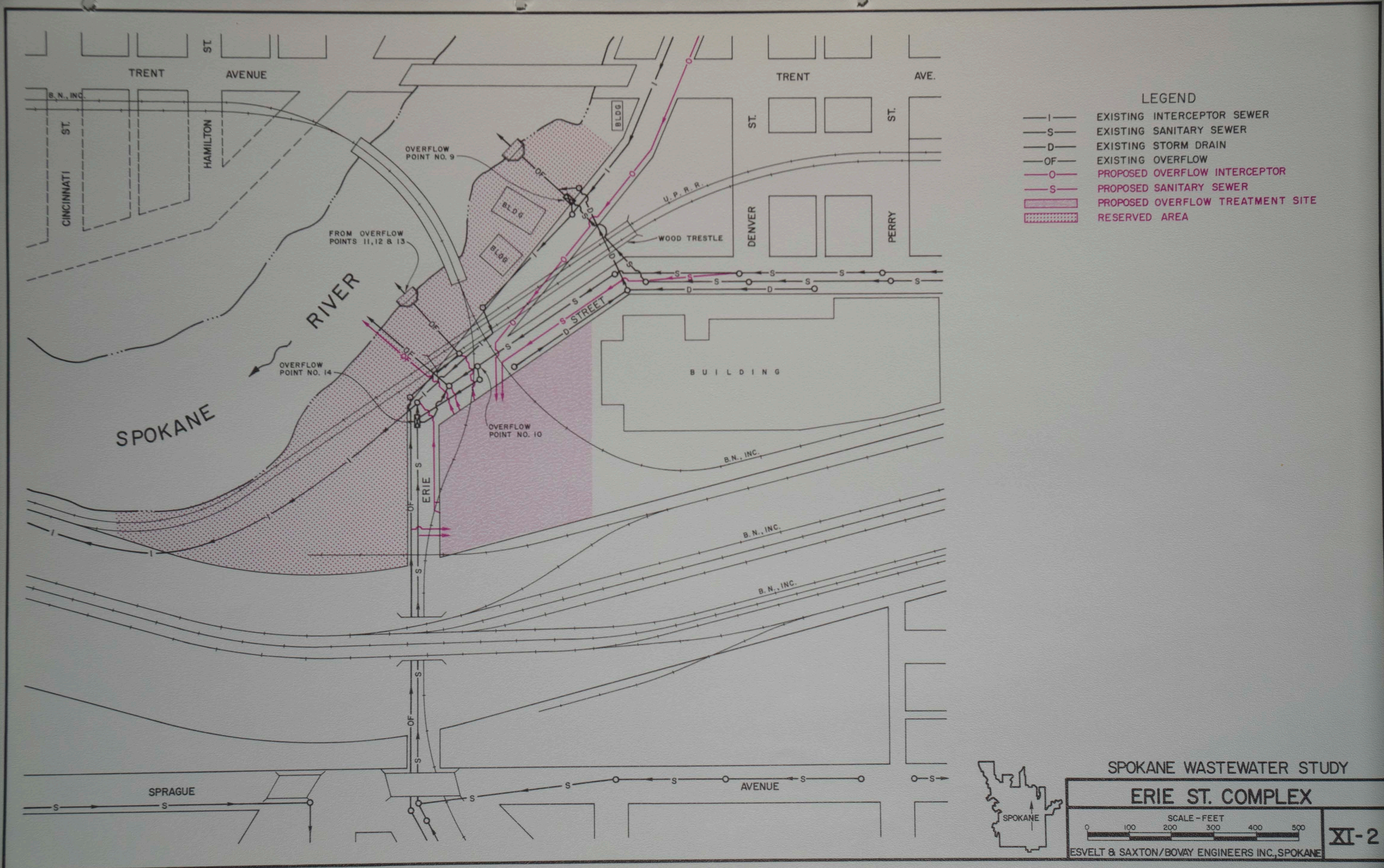
OVERFLOW TREATMENT FACILITY
SCHEMATIC FLOW DIAGRAM



ERIE STREET COMPLEX
PHASE I SCHEMATIC
BYPASS ELIMINATION

SPOKANE WASTEWATER STUDY

OVERFLOW TREATMENT SCHEM.	
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE	XI-1


TRENT
AVENUE
ST.
B.N., INC.
CINCINNATI ST.
HAMILTON
SPOKANE RIVER
OVERFLOW POINT NO. 9
FROM OVERFLOW POINTS 11, 12 & 13
OVERFLOW POINT NO. 14
OVERFLOW POINT NO. 10
BLDG
U.P.R.R.
WOOD TRESTLE
TRENT
AVE.
ST.
DENVER
ST.
PERRY
STREET
ERIE
BUILDING
B.N., INC.
B.N., INC.
B.N., INC.
SPRAGUE
AVENUE
LEGEND
EXISTING INTERCEPTOR SEWER
EXISTING SANITARY SEWER
EXISTING STORM DRAIN
EXISTING OVERFLOW
PROPOSED OVERFLOW INTERCEPTOR
PROPOSED SANITARY SEWER
PROPOSED OVERFLOW TREATMENT SITE
RESERVED AREA
SPOKANE
SPOKANE WASTEWATER STUDY
ERIE ST. COMPLEX
SCALE - FEET
0 100 200 300 400 500
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
XI-2

LEGEND

- —I— EXISTING INTERCEPTOR SEWER
- —S— EXISTING SANITARY SEWER
- —D— EXISTING STORM DRAIN
- —OF— EXISTING OVERFLOW
- —O— PROPOSED OVERFLOW INTERCEPTOR
- —S— PROPOSED SANITARY SEWER REPLACEMENT
- —I— PROPOSED INTERCEPTOR SEWER

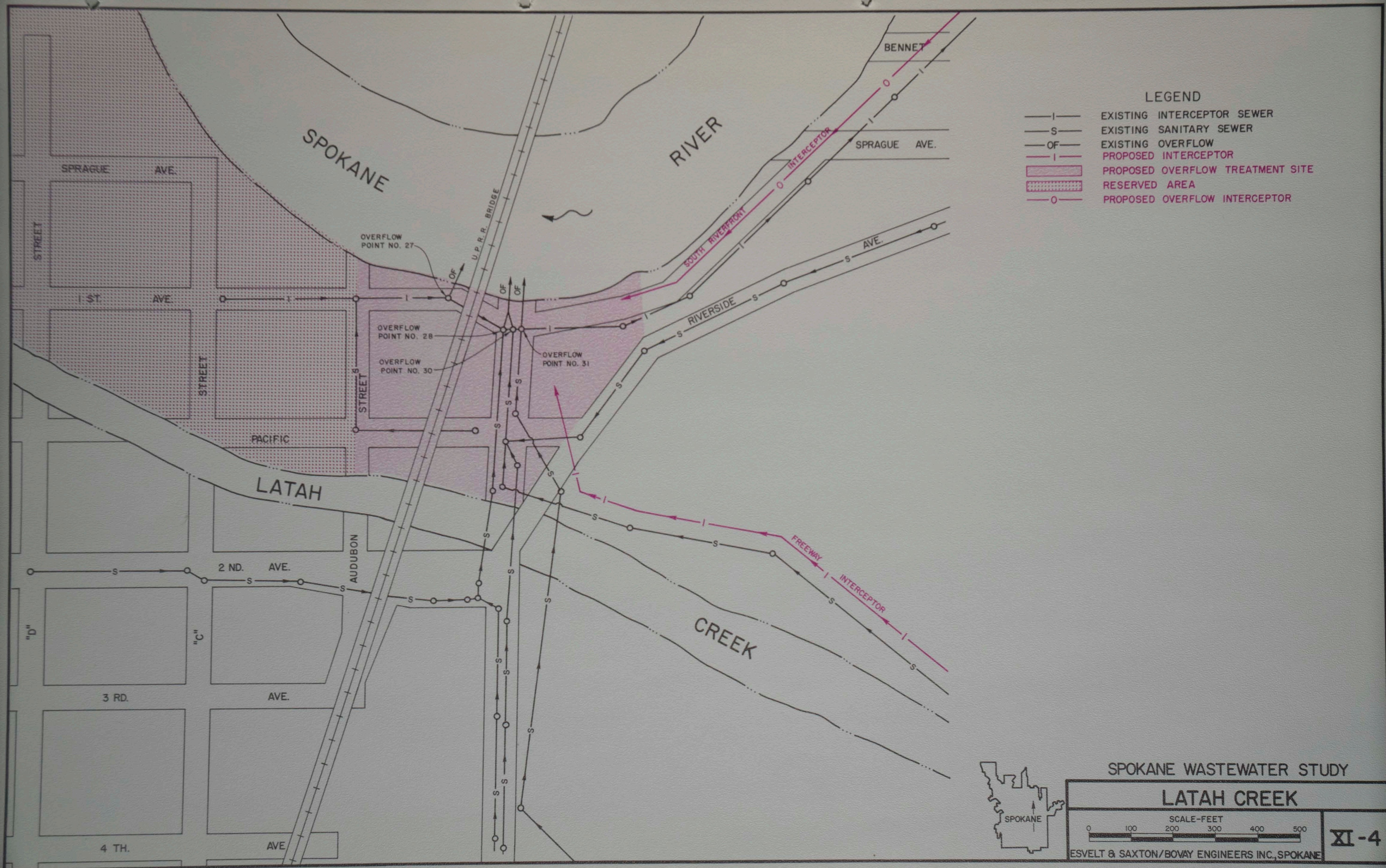
SPOKANE WASTEWATER STUDY

CBD IMPROVEMENTS

SCALE-FEET
0 400 800 1200 1600 2000

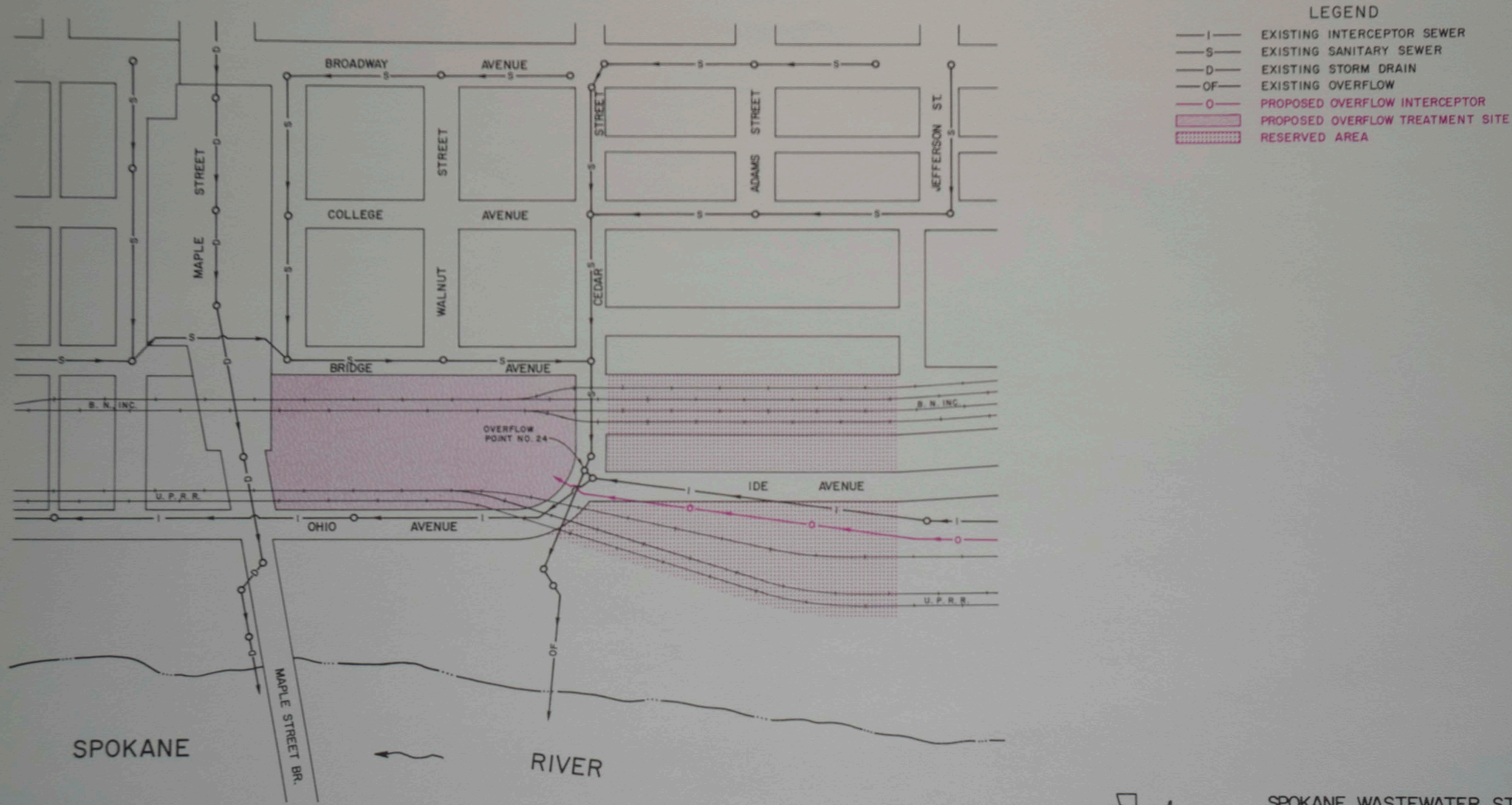
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

XI-3



LEGEND
EXISTING INTERCEPTOR SEWER
EXISTING SANITARY SEWER
EXISTING OVERFLOW
PROPOSED INTERCEPTOR
PROPOSED OVERFLOW TREATMENT SITE
RESERVED AREA
PROPOSED OVERFLOW INTERCEPTOR
SPOKANE
RIVER
LATAH
CREEK
U.P.R.R. BRIDGE
OVERFLOW POINT NO. 27
OVERFLOW POINT NO. 28
OVERFLOW POINT NO. 30
OVERFLOW POINT NO. 31
SOUTH RIVERFRONT INTERCEPTOR
FREEWAY INTERCEPTOR
BENNET
SPRAGUE AVE.
SPRAGUE AVE.
RIVERSIDE AVE.
1 ST. AVE.
PACIFIC
2 ND. AVE.
3 RD. AVE.
4 TH. AVE
STREET
STREET
STREET
AUDUBON
"D"
"C"
SPOKANE
SPOKANE WASTEWATER STUDY
LATAH CREEK
SCALE-FEET
0 100 200 300 400 500
XI-4
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE


LEGEND
EXISTING INTERCEPTOR SEWER
EXISTING SANITARY SEWER
EXISTING STORM DRAIN
EXISTING OVERFLOW
PROPOSED OVERFLOW INTERCEPTOR
BUCKEYE AVE.
JACKSON AVE.
MARIETTA AVE.
CARLISLE AVE.
MONTGOMERY AVE.
ILLINOIS AVE.
ERMINA AVE.
BALDWIN AVE.
INDIANA AVE.
NORA AVE.
AUGUSTA AVE.
MISSION AVE.
SINTO AVE.
SHARP AVE.
BOONE AVE.
DESMET AVE.
CATALDO AVE.
GARDNER AVE.
DEAN AVE.
NORTHWEST BLVD.
COLISEUM
GONZAGA UNIV.
DIVISION ST.
WASHINGTON
NORMANDIE ST.
ATLANTIC ST.
HOWARD ST.
STEVENS
JEFFERSON ST.
WALNUT ST.
MAPLE
RUBY ST.
PEARL ST.
ADDISON
STANDARD ST.
HAMILTON
IDE AVE.
OHIO AVE.
HAVERMALE AVE.
OVERFLOW POINT NO. 19
OVERFLOW POINT NO. 20
OVERFLOW POINT NO. 21
OVERFLOW POINT NO. 22
OVERFLOW POINT NO. 23
OVERFLOW POINT NO. 24
OVERFLOW TREATMENT SITE, SEE EXHIBIT XI-6
SPOKANE RIVER
SPOKANE
SPOKANE WASTEWATER STUDY
NORTH BOWL AREA
SCALE-FEET
0 400 800 1200 1600 2000
XI-5
ESVELT & SAXTON/BOVAY ENGINEERS INC, SPOKANE



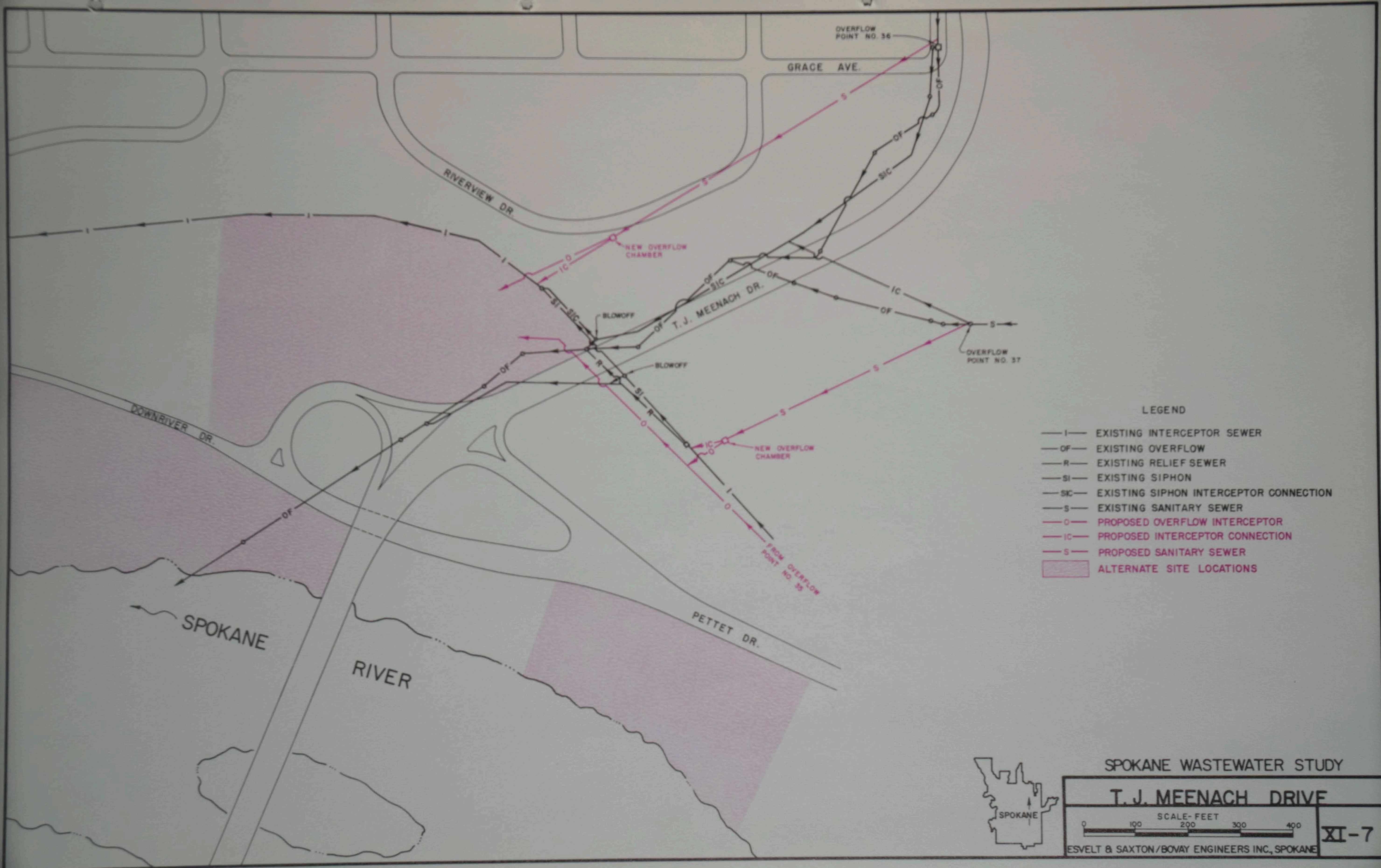
SPOKANE WASTEWATER STUDY

CEDAR AND IDE

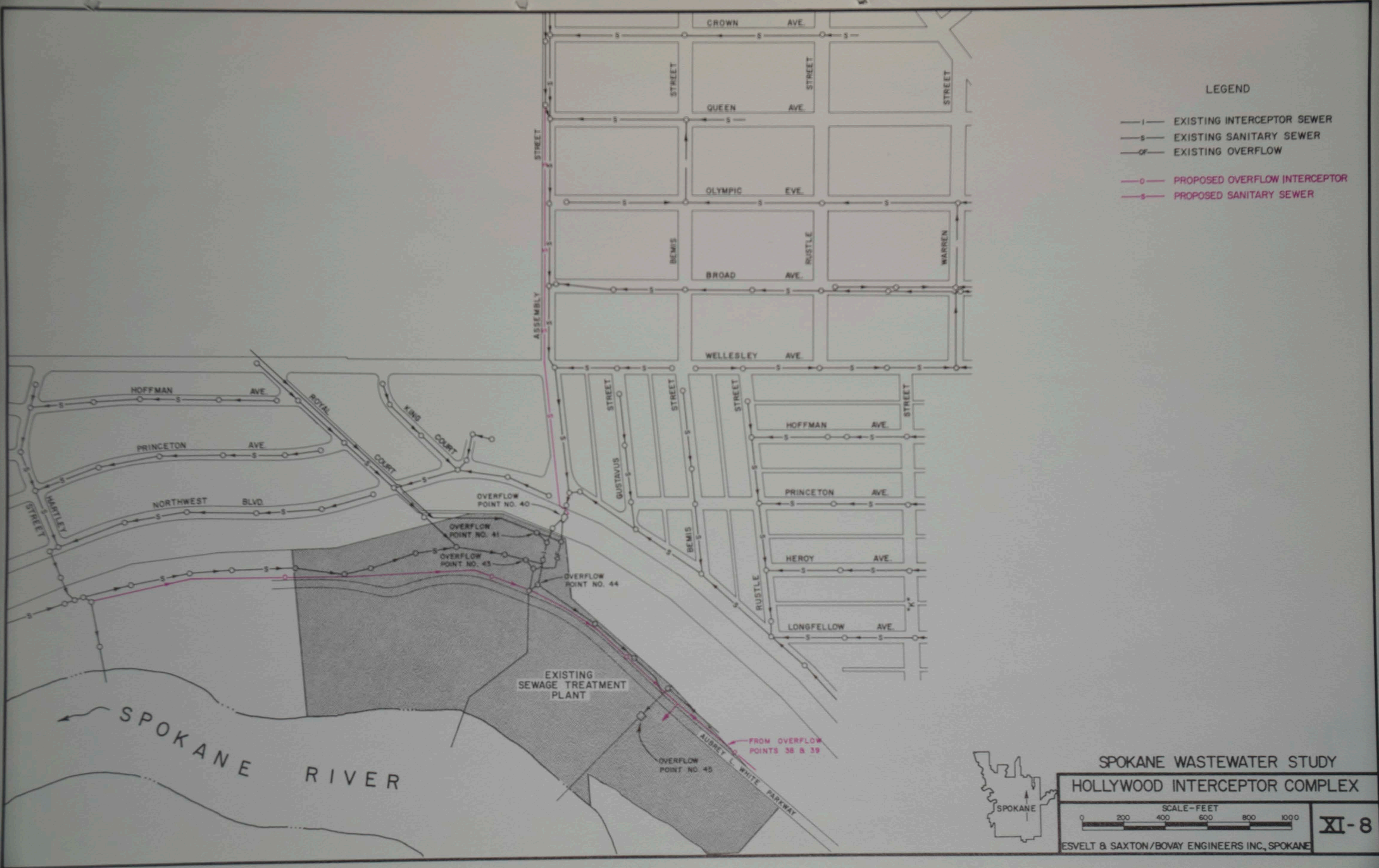
SCALE-FEET 0 100 200 300 400 500

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

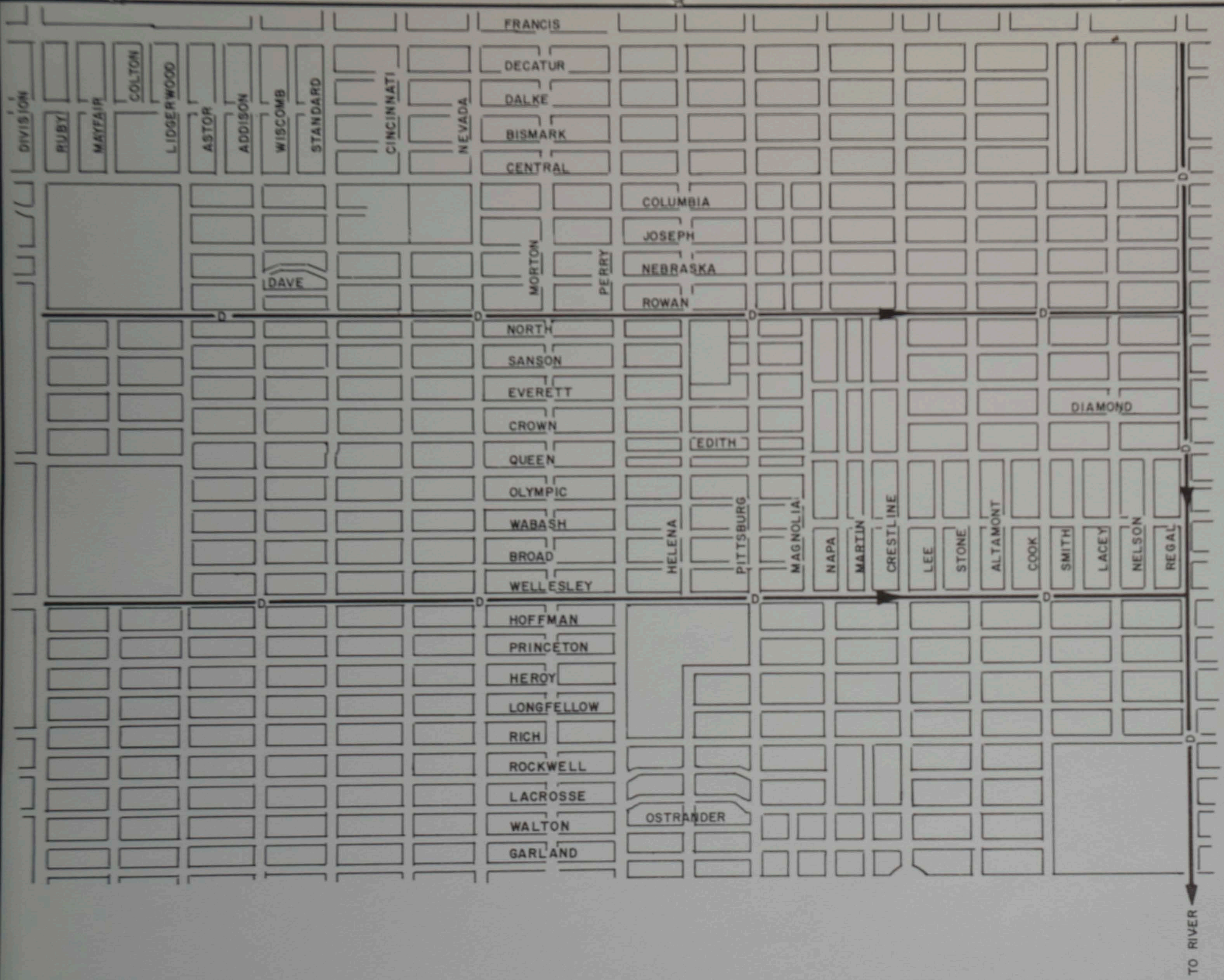
XI-6



OVERFLOW POINT NO. 36
GRACE AVE.
RIVERVIEW DR.
NEW OVERFLOW CHAMBER
BLOWOFF
BLOWOFF
T. J. MEENACH DR.
OVERFLOW POINT NO. 37
DOWNRIVER DR.
NEW OVERFLOW CHAMBER
FROM OVERFLOW POINT NO. 35
PETTET DR.
SPOKANE
RIVER
LEGEND
I — EXISTING INTERCEPTOR SEWER
OF — EXISTING OVERFLOW
R — EXISTING RELIEF SEWER
SI — EXISTING SIPHON
SIC — EXISTING SIPHON INTERCEPTOR CONNECTION
S — EXISTING SANITARY SEWER
O — PROPOSED OVERFLOW INTERCEPTOR
IC — PROPOSED INTERCEPTOR CONNECTION
S — PROPOSED SANITARY SEWER
ALTERNATE SITE LOCATIONS
SPOKANE
SPOKANE WASTEWATER STUDY
T. J. MEENACH DRIVE
SCALE- FEET
0 100 200 300 400
ESVELT & SAXTON/BOVAY ENGINEERS INC, SPOKANE
XI-7


LEGEND
EXISTING INTERCEPTOR SEWER
EXISTING SANITARY SEWER
EXISTING OVERFLOW
PROPOSED OVERFLOW INTERCEPTOR
PROPOSED SANITARY SEWER
CROWN AVE.
QUEEN AVE.
OLYMPIC EVE.
BROAD AVE.
WELLESLEY AVE.
HOFFMAN AVE.
PRINCETON AVE.
HEROY AVE.
LONGFELLOW AVE.
NORTHWEST BLVD.
ASSEMBLY STREET
BEMIS STREET
RUSTLE STREET
WARREN STREET
GUSTAVUS STREET
HARTLEY STREET
ROYAL COURT
KING COURT
"K"
OVERFLOW POINT NO. 40
OVERFLOW POINT NO. 41
OVERFLOW POINT NO. 43
OVERFLOW POINT NO. 44
OVERFLOW POINT NO. 45
FROM OVERFLOW POINTS 38 & 39
AUBREY L. WHITE PARKWAY
EXISTING SEWAGE TREATMENT PLANT
SPOKANE RIVER
SPOKANE
SPOKANE WASTEWATER STUDY
HOLLYWOOD INTERCEPTOR COMPLEX
SCALE-FEET
0 200 400 600 800 1000
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

XI-8



LEGEND

—D— PROPOSED STORM SEWER

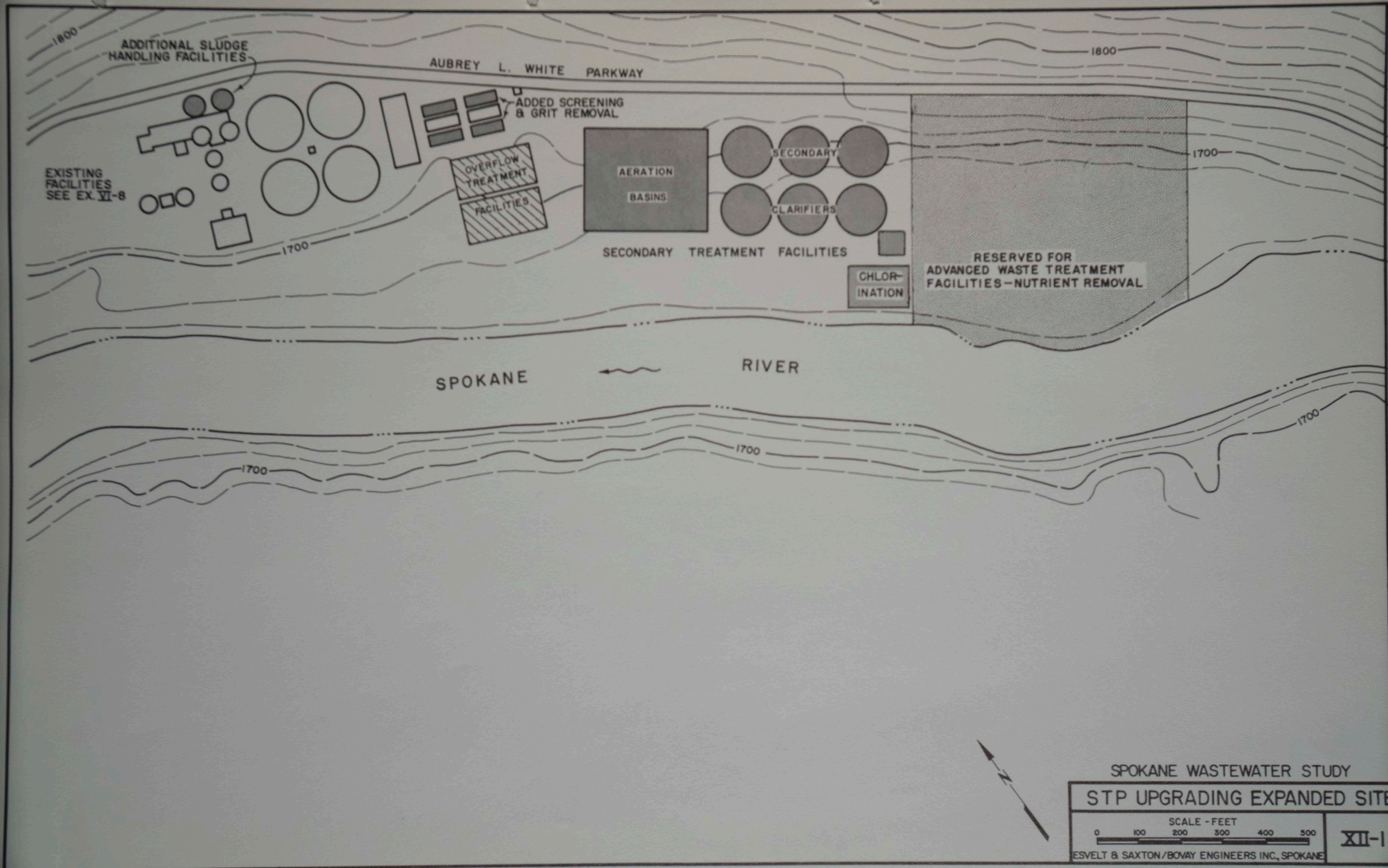
SPOKANE WASTEWATER STUDY

N.E. STORM RELIEF

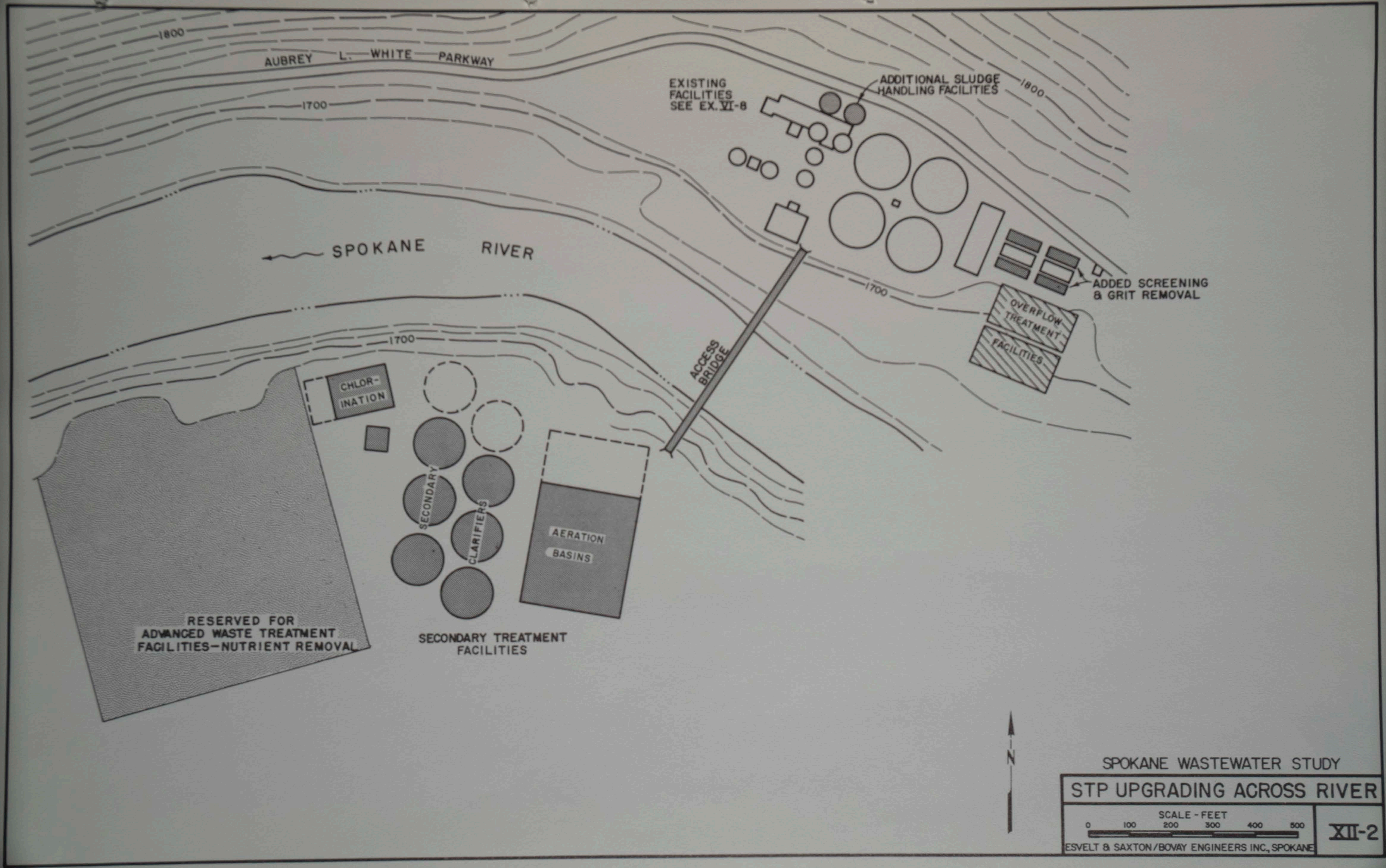
SCALE - FEET
0 1000 2000

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

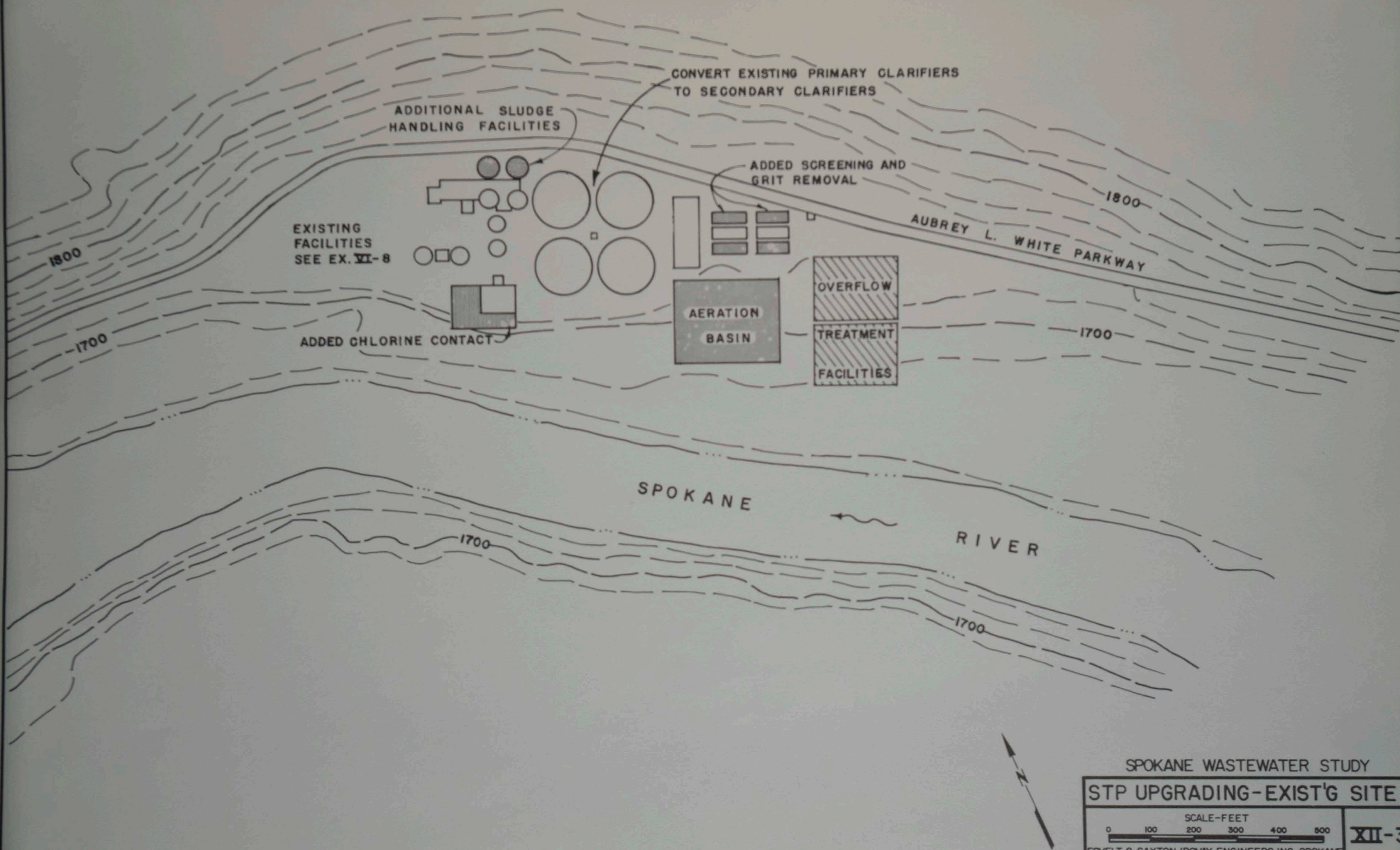
XI-9



ADDITIONAL SLUDGE HANDLING FACILITIES
AUBREY L. WHITE PARKWAY
ADDED SCREENING & GRIT REMOVAL
1800
1800
EXISTING FACILITIES SEE EX. VI-8
OVERFLOW TREATMENT FACILITIES
AERATION BASINS
SECONDARY CLARIFIERS
1700
1700
SECONDARY TREATMENT FACILITIES
CHLOR-INATION
RESERVED FOR ADVANCED WASTE TREATMENT FACILITIES—NUTRIENT REMOVAL
SPOKANE RIVER
1700
1700
1700
N
SPOKANE WASTEWATER STUDY
STP UPGRADING EXPANDED SITE
SCALE - FEET
0 100 200 300 400 500
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
XII-1



1800
AUBREY L. WHITE PARKWAY
1700
EXISTING FACILITIES SEE EX. VI-8
ADDITIONAL SLUDGE HANDLING FACILITIES
1800
SPOKANE RIVER
1700
ADDED SCREENING & GRIT REMOVAL
OVERFLOW TREATMENT FACILITIES
1700
ACCESS BRIDGE
CHLOR-INATION
SECONDARY CLARIFIERS
AERATION BASINS
RESERVED FOR ADVANCED WASTE TREATMENT FACILITIES—NUTRIENT REMOVAL
SECONDARY TREATMENT FACILITIES
N
SPOKANE WASTEWATER STUDY
STP UPGRADING ACROSS RIVER
SCALE - FEET
0 100 200 300 400 500
ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE
XII-2

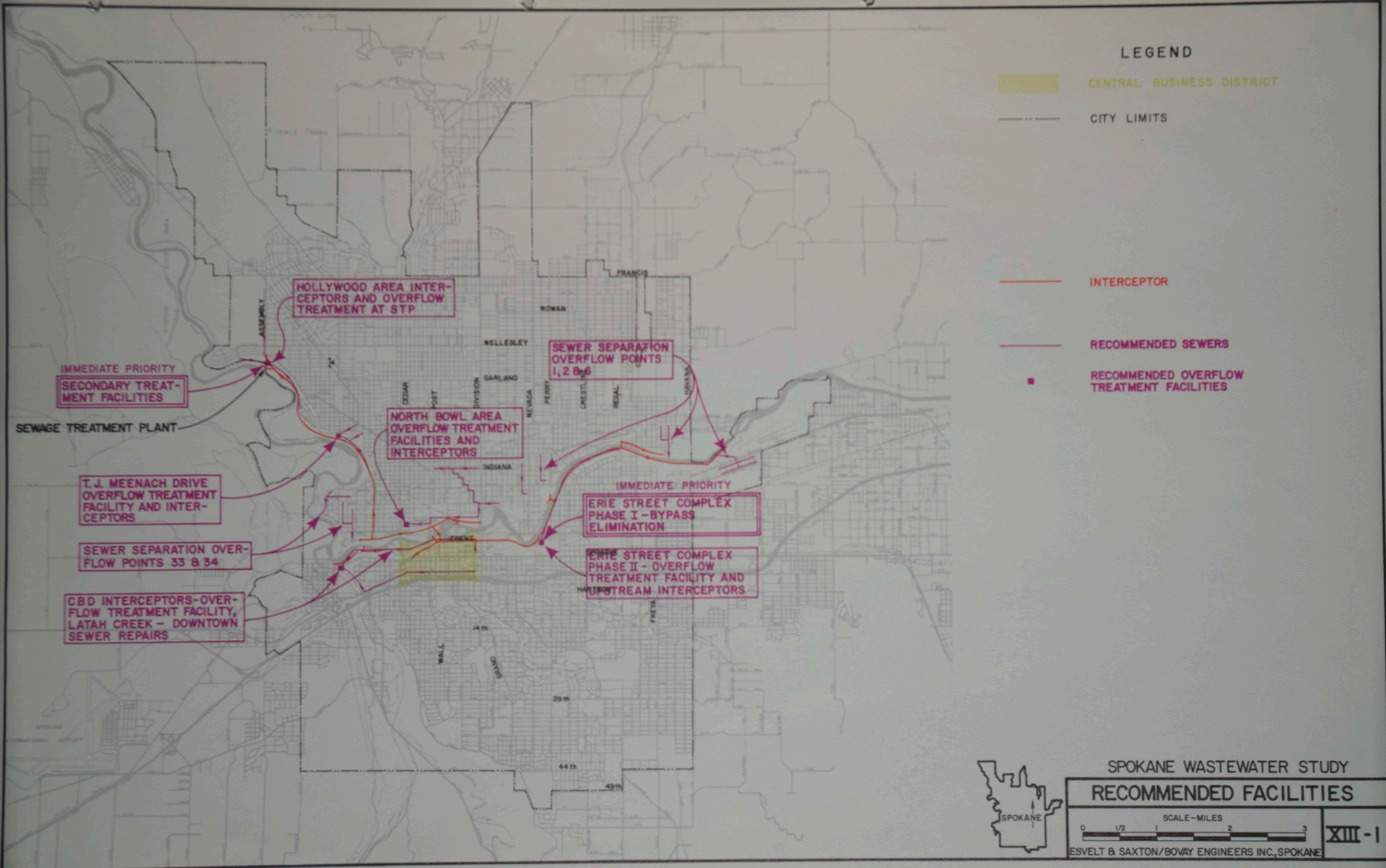


SPOKANE WASTEWATER STUDY

STP UPGRADING-EXIST'G SITE

ESVELT & SAXTON/BOVAY ENGINEERS INC., SPOKANE

XII-3



SPOKANE WASTEWATER STUDY

RECOMMENDED FACILITIES

XIII - 1